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ABSTRACT

In Fall 1975, PMDC investigators administered a battery of tests to 185 first graders and 152 second graders to assess children's progress in acquiring mathematical concepts and skills during the beginning school years. Two tests were constructed by PMDC and this document reports item statistics and results from these tests; copies of the tests are included in this volume. Summaries of results from a mental abilities test and a diagnostic arithmetic test are also given. (MS)

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PMDC Technical Report
No. 4

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Description and Statistical Results of the 1975 Fall Testing Program

Cynthia A. Clarke

SE 023 561

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PREFACE

Ed Begle recently remarked that curricular efforts during the 1960's taught us a great deal about how to teach better mathematics, but very little about how to teach mathematics better. The mathematician will, quite likely, agree with both parts of this statement. The layman, the parent, and the elementary school teacher, however, question the thesis that the "new math" was really better than the "old math." At best, the fruits of the mathematics curriculum "revolution" were not sweet. Many judge them to be bitter.

While some viewed the curricular changes of the 1960's to be "revolutionary," others disagreed. Thomas C. O'Brien of Southern Illinois University at Edwardsville recently wrote, "We have not made any fundamental change in school mathematics."[1] He cites Allendoerfer who suggested that a curriculum which heeds the ways in which young children learn mathematics is needed. Such a curriculum would be based on the understanding of children's thinking and learning. It is one thing, however, to recognize that a conceptual model for mathematics curriculum is sound and necessary and to ask that the child's thinking and learning processes be heeded, it is quite another to translate these ideas into a curriculum which can be used effectively by the ordinary elementary school teacher working in the ordinary elementary school classroom.

Moreover, to propose that children's thinking processes should serve as a basis for curriculum development is to presuppose that curriculum makers agree on what these processes are. This is not the case, but even if it were, curriculum makers do not agree on the implications which the understanding of these thinking processes would have for curriculum development.

In the real world of today's elementary school classroom, where not much hope for drastic changes for the better can be foreseen, it appears that in order to build a realistic, yet sound basis for the mathematics curriculum, children's mathematical thinking must be studied intensively in their usual school habitat. Given an opportunity to think freely, children clearly display certain patterns of thought as they deal with ordinary mathematical situations encountered daily in their classroom. A videotaped record of the outward manifestations of a child's thinking, uninfluenced by any teaching on the part of the interviewer, provides a rich source for conjectures as to what this thinking is, what mental structures the child has developed, and how the child uses these structures when dealing with the ordinary concepts of arithmetic. In addition, an intensive analysis of this videotape generates some conjectures as to the possible sources of what adults view as children's "misconceptions" and about how the school environment (the teacher and the materials) "fights" the child's natural thought processes.

The Project for the Mathematical Development of Children (PMDC)[2] set out to create a more extensive and reliable basis on which to build mathematics curriculum. Accordingly, the emphasis in the first phase is to try to understand the children's intellectual pursuits, specifically their attempts to acquire some basic mathematical skills and concepts.

The PMDC, in its initial phase, works with children in grades 1 and 2. These grades seem to comprise the crucial years for the development of bases for the future learning of mathematics, since key mathematical concepts begin to form at these grade levels. The children's mathematical development is studied by means of:

1. One-to-one videotaped interviews subsequently analyzed by various individuals.

2. Teaching experiments in which specific variables are observed in a group teaching setting with five to fourteen children.

3. Intensive observations of children in their regular classroom setting.

4. Studies designed to investigate intensively the effect of a particular variable or medium on communicating mathematics to young children.

[1] "Why Teach Mathematics?" The Elementary School Journal 73 (Feb. 1973), 258-68.

[2] PMDC is supported by the National Science Foundation, Grant No. PES 74-18106-A03.

5. Formal testing, both group and one-to-one, designed to provide further insights into young children's mathematical knowledge.

The PMDC staff and the Advisory Board wish to report the Project's activities and findings to all who are interested in mathematical education. One means for accomplishing this is the PMDC publication program.

This publication is intended to share with the reader the information obtained from the Fall 1975 Testing Program, including a summary of the data collected during the program and copies of the PMDC Grade 1 and Grade 2 Tests. We hope the reader will find this publication to be a rich source of ideas about the mathematical status of first and second grade children.

Many individuals contributed to the activities of PMDC. Its Advisory Board members are: Edward Begle, Edgar Edwards, Walter Dick, John LeBlanc, Gerald Rising, Charles Smock, Stephen Willoughby, and Lauren Woodby. The principal investigators are: Merlyn Behr, Cynthia Clarke, Thomas Cooney, Tom Denmark, Larry Hatfield, William McKillip, Eugene D. Nichols, Leslie Steffe, and the Evaluator, L. Ray Carry. A special recognition for the publication is given to the PMDC Publications Committee, consisting of Merlyn Behr (Chairman), Thomas Cooney, and Tom Denmark. Thanks are also due the graduate students who participated in the administration of the tests: Ella Barco, Pat Campbell, Judy Voran, and Stewart Wood at Florida State University, and Blanca Alvarez-Mena, Marriee Davis, Tim Cathany, Kathy Hamrick, David Mack, Curtis Spikes, and Nancy Wein at the University of Georgia; to the statistician, Herbert Lacayo, for carrying out the computer analysis of the test results; to the Project technical assistant, Max Gerling, for videotape production; to the Project administrative assistant, Janelle Hardy, for coordinating the technical aspects of the preparation of this report; to Lucy Kalogera and Maria Pitner for editing the manuscript; and to Joe Schmerler for the typing.

Eugene D. Nichols
Director of PMDC

FOREWORD

In the fall of 1975, the Project for the Mathematical Development of Children administered a battery of tests to 185 first grade children and 152 second grade children in an effort to assess children's progress in acquiring mathematical concepts and skills during the beginning school years.

The study population was selected from five schools, three located in Athens, Georgia, and two located in Tallahassee, Florida. The population within each school included students from a wide range of socioeconomic classifications as defined by family income, parental education, and parental occupation. The composition of students by socioeconomic variables varied considerably among schools. Descriptive statistics of the sample by school and information about the schools are provided in Appendix A.

Two tests, one for Grade 1 and one for Grade 2, were constructed by PMDC and administered to each child in the respective grades. This volume is primarily a report of the results of this testing. Copies of these tests are presented in Appendices B and C.

In addition, the Otis-Lennon Mental Ability Test and the KeyMath Diagnostic Arithmetic Test were administered to each child in the sample. Summaries of these test results are presented in Appendices D and E, respectively.

Principal investigators and graduate students participated in the administration of the testing. All testers were required to attend training sessions before administering the tests. Throughout the training sessions, the importance of strict adherence to the instructions was stressed.

GUIDE FOR THE USE OF THIS VOLUME

The first part of this volume contains information about PMDC Tests, Grades 1 and 2. The tests themselves are reproduced in Appendices B and C, respectively.

The second part of this volume contains the description and statistical properties of the Grade 1 and Grade 2 PMDC Tests and scales. Figure 1 is a sample page from this part of the report. The information for all scales is presented in this basic format. A key for explaining Figure 1 follows:

1. GRADE LEVEL. The grade level of the students taking the scale.

2. SCALE NAME. The scale name is usually descriptive of the content of the scale.

3. SCALE LENGTH. The number of items in the scale is indicated in parentheses following the scale name. This number is also reported in the second line under the Scale Statistics.

4. SCALE DESCRIPTION. A brief description of the scale is given, telling what the scale is designed to measure, and giving any special information about the scale.

5. ITEM AND PAGE REFERENCE. The item numbers and the pages in the appendices where the items are reproduced are given.

6. NUMBER OF CASES. The data in this volume are reported on the total number of students to whom the scale was administered.

7. MEAN TOTAL SCORE. This is the mean for scale scores. The scale score is the number of items correct when the responses to items are assessed on a right/wrong basis.

8. STANDARD DEVIATION. The standard deviation of scale scores.

9. CRONBACH'S ALPHA. The coefficient alpha is an estimate of the internal consistency and reliability of the scale.

10. ERROR OF MEASUREMENT. The standard error of measurement of a scale is an index of the extent to which scores would vary over similar tests. It is a function of the standard deviation and alpha,

$$(\text{ERR. MEAS.}) = (\text{ST. DEV.}) \sqrt{(1.0 - \text{ALPHA})}$$

It can be used to establish a confidence interval around an obtained score to estimate the region in which a true score probably lies.

11. ITEM. This is the number of the item for which the statistics are reported. Page references for each item in the scale are given in 5 above.

12. ITEM MEAN. P is the mean on the item for all students in the sample.

13. ADJUSTED ITEM MEAN. ADJ. P for an item is the mean for all students who attempted an item. Not tried responses are eliminated from the calculation of ADJ. P. An item is defined as not tried if there was no response to the item.

14. BISERIAL CORRELATION. N. S. BIS is given as an index of item discrimination for items scored right or wrong. The *non-spurious* biserial correlation is the correlation between the item and the total scale score *with the item removed.*

15. PERCENT NOT TRIED. The percent of students for whom the item was not tried is indicated by PERCENT NT.

GRADE 1 (1)

(2) ADDITION-SUBTRACTION (6 items) (3)

(4) This scale is composed of six tasks designed to measure the pupil's ability to solve addition and subtraction problems, mentally and with manipulatives. The item numbers and page references are listed below.

(5) Items 13, 27, 31, 37, 39, 43; Pages 26, 28, 30, 31, 31, 32

SCALE STATISTICS:

(6) NUMBER OF CASES = 185

(3) NUMBER OF ITEMS = 6

(7) MEAN TOTAL SCORE = 2.936

(8) STANDARD DEVIATION = 1.615

(9) CRONBACH'S ALPHA = .644

(10) ERROR OF MEASUREMENT = .964

ITEM STATISTICS:

(11) ITEM	(12) P's	(13) ADJ. P's	(14) N. S. BIS	(15) PERCENT NT
13	.553	.581	.386	4.8
27	.362	.410	.338	11.7
31	.348	.365	.384	7.0
37	.723	.751	.368	3.7
39	.782	.808	.421	3.2
43	.154	.174	.362	11.2

Figure 1

PART I: INFORMATION ABOUT THE PMDC MATHEMATICS TESTING PROGRAM

I. INTRODUCTION

PMDC Grade 1 and Grade 2 Tests

The PMDC Grade 1 and Grade 2 Tests were designed to assess certain mathematical concepts and skills of interest to the Project. The tests were given during the second week of school to a sample of 185 first grade students and 152 second grade students from five schools.

The Grade 1 Test consists of six scales: Elementary Counting, Advanced Counting, Addition-Subtraction, Set Equivalence, Ordering, and Class Inclusion. The Grade 2 Test consists of nine scales: Elementary Counting, Advanced Counting, Patterns, Place Value, Equivalent Names, Ordering, Addition-Subtraction, Missing Addend, and Class Inclusion. The tests were individually administered and each took about 20 minutes to administer.

For the rote counting items an alternate form of directions in the case of no response was provided. For example, if, when asked to "Count by tens for me." the student gave no response, the alternate form "I want you to count like this: ten, twenty, thirty. Now you do it." was given. Each rote counting item has two numbered boxes for recording responses. The first was used if the student responded to the initial instructions. The response was entered in the second box if the alternate directions were required.

On selected items (e.g., Items 1, 8, 20, Grade 1) the method which the student used to obtain the response was also recorded. The information obtained from these items is presented with the tests in Appendices B and C and is recorded on the page with each test item.

The testers attended a training session during which they watched videotapes of testings and recorded the students' responses. Afterward the responses recorded by each tester were compared and discrepancies discussed. The directions to the testers and response forms are reproduced on the following pages.

II. EXAMINER'S MANUAL FOR PMDC MATHEMATICS TEST[3]

The PMDC Mathematics Test is an individually administered test consisting of two levels: G1 for Grade 1 students and G2 for Grade 2 students. The purpose of the PMDC Test is to assess those concepts and skills of interest to the PMDC Staff which were not tested by the KeyMath Diagnostic Arithmetic Test. The items in each level of the PMDC Test are organized from easy to difficult, combining several content strands. That is, students will receive the easier counting, vocabulary, and computation items prior to the more difficult counting, vocabulary, and computation items.

I. TEST MATERIALS

A. *Examiner's Manual*

The PMDC Mathematics Test is administered mainly from instructions incorporated with the test items. The purpose of this manual is to provide additional guidelines to insure that all students experience as nearly as possible the same testing situation.

Part I of this manual presents a description of the test materials.

Part II presents guidelines for the preparation for the administration of the test.

Part III presents guidelines for meeting the student and introducing the test.

Part IV presents guidelines for administering the test.

Part V discusses the completion of testing.

Part VI presents guidelines for scoring the tests.

Part VII presents guidelines for securing the information necessary for data analysis.

B. *Test Kit*

The test items make up the loose-leaf notebook interior. When opened and placed on its stand, the notebook forms an easel which presents the stimuli material to the subject and at the same time provides the examiner with instructions, test items, manipulatives or pictures needed, and the numerical key to the PMDC Response Form. Separate test kits for Grade 1 and Grade 2 have been prepared.

C. *PMDC Response Form*

1. Description

There are separate response forms for Grade 1 and Grade 2. Each form is numerically keyed to its grade level test items. To the right of each item's instruction to the student is an encircled number corresponding to a box with the same number on the response form. This corresponding box is to be used for recording the student's response to the item's instruction. On the right hand side of the response form is a section in which the examiner can provide additional information about the test items or the student's test behavior or responses.

2. Format

The response boxes are arranged sequentially from left to right across the response form by rows. For example, on the Grade 1 PMDC Response Form, boxes 1-11 appear from left to right on row 1, and boxes 12-24 appear from left to right on row 2.

[3]Pages 2-6 contain the Examiner's Manual used by the PMDC examiners in the 1975 Fall Testing Program. The Examiner's Manuals prepared for distribution in the Grade 1 and Grade 2 testing packets are variants of this manual.

More than one box may be placed together (see Grade 1, boxes 1 and 2). This means that one item demands two separate responses from the student and thus requires a separate box for each response.

3. Columns

Each box may be comprised of one or two columns. Generally the first (or only) column is for recording the student's response. This column is generally titled RESPONSE, but may be assigned a more descriptive title such as NO. BEANS. Within this column is NO ATTEMPT, the correct response (indicated by parentheses), other possible responses, and a blank area for recording a not-listed response.

The second column is for recording the student's errors or method used for responding. Listed are the more probable alternative errors or methods. The alternative OTHER is to be circled when the student makes an error or uses a method not listed. The examiner may want to elaborate on the error or method and should do so in the COMMENTS section of the response form.

D. *Manipulatives and Pictures*

Each grade level test has a set of manipulatives and pictures in addition to the pictures contained in the test kit which are necessary for administration. The materials specified in the tables below should be assimilated prior to testing. On each item page is a list of materials needed to present the item.

GRADE 1

Materials	Items
25 beans	2, 7, 12, 14, 18, 20, 24, 26
Card with 5 ducks	5
2 boxes, 9 fordhook beans, 9 baby limas	10
Card with 7 stars	12
Card with 2 circles and a square	18

GRADE 2

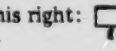
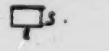
Materials	Items
4 cards with 5, 3, 9, 2	2
25 beans	4, 6, 13, 16
3 cards with 6 + 3, 4 + 1, 6 - 1	10
3 cards with 5 - 2, 10 - 5, 4 + 1	15
6 bundles of 10 straws each, 9 single straws	23, 24, 25, 26
6 red chips, 9 white chips	28, 29, 30, 31

II. PREPARATION FOR ADMINISTRATION

A. *Instructions*

Become familiar with the guidelines detailed in this manual. Since the PMDC Test is administered from instructions incorporated with the test items, become familiar with the test items and materials prior to testing.

B. *Seating*

To allow the examiner to view both sides of the test kit and to shield the PMDC Response Form from the student, a right-handed examiner should seat the student on her/his left:  ; a left-handed examiner should seat the student on her/his right:  .

C. *Materials*

Be sure that all materials (Test Kit, PMDC Response Form, manipulatives and pictures) are assimilated prior to the administration. Place the manipulatives and pictures so that they are accessible to the

examiner and shielded from the student. On each item page is a list of the manipulatives and/or pictures which accompany the item.

III. MEETING THE STUDENT

Attempt to put the student at ease.

Introduce yourself to the student.
HELLO, MY NAME IS . . .

Ask the student her/his full name if you do not know it.
WHAT IS YOUR FIRST NAME? WHAT IS YOUR LAST NAME?

Fill in the blank on the PMDC Response Form for the STUDENT'S NAME.

Spend approximately 30 seconds in social conversation. Suggested leading questions are:
DO YOU HAVE ANY BROTHERS OR SISTERS?
DO YOU HAVE ANY PETS?
HOW OLD ARE YOU? WHEN IS YOUR BIRTHDAY?
WHO IS YOUR TEACHER?

Introduce the Test
Do *not* refer to the PMDC Test as a test or a game. There are two main points you need to convey. The suggested dialogue is:
WE ARE GOING TO LOOK AT A BOOK WHICH CONTAINS SOME INTERESTING PICTURES AND QUESTIONS.
(pause)
I'LL ASK YOU SOME QUESTIONS ABOUT THE PICTURES. YOU ANSWER THEM. IF I ASK YOU ABOUT SOMETHING YOU HAVEN'T LEARNED, JUST TELL ME YOU DON'T KNOW AND I'LL SHOW YOU ANOTHER PICTURE, O.K.?

IV. TESTING

A. *Follow the written directions carefully.* The examiner may probe to get an answer with the statement "TELL ME MORE." Do not probe any further except when specified in the written directions for the question.

Remember, this is an evaluation and should not be used as a teaching situation.

Address questions and comments to the student, not the book or the response form. Eye contact is important for control and rapport. Use *reassurances* without specifying that responses are right or wrong. This may be done in a variety of ways.

1. Repeat what the student has said in a reassuring voice.

2. Remarks should be positive and limited to "UM-HUM," "ALL RIGHT," "FINE," and "O.K."

3. Physical expressions should be positive and limited to a smile and a nod of the head.

To regain a student's attention, the examiner may precede the question with "O.K."; the student's name, and/or "NOW, HERE ARE SOME *MORE* INTERESTING PICTURES AND QUESTIONS."

If a student does not understand the question, *repeat the written question* only. Remember, rephrasing a question would violate the standardization of the administration.

B. *Time Limits*

If the student does not respond after 15 seconds, point to the item and ask:
DO YOU KNOW HOW TO DO THIS?

If the student says "YES," allow 10 more seconds for a response. If the student says "NO," or does not respond after the additional 10 seconds, proceed to the next item with,

LET'S DO SOMETHING ELSE.

C. *Recording*

Record student responses by *circling* the appropriate alternative in the item column(s), with the corresponding numerical key as the item.

1. RESPONSE column. This column is generally titled RESPONSE, but may be assigned a more descriptive title such as NO. BEANS.

   a) If a student says he does not know the answer or know how to answer or does not respond at all, circle the alternative NO ATTEMPT.

   b) If a student responds correctly, circle the alternative enclosed in parentheses.

   c) If a student responds incorrectly and that response is listed as an alternative, circle the alternative.

   d) If a student responds incorrectly and that response is not listed, write briefly the response in the lower blank section.

2. ERROR column. This column is used for the verbal counting items.

   a) If a student omits one number while counting, for example, 1, 2, 4, 5, circle the alternative SKIP NUMBER.

   b) If a student orders two numbers incorrectly while counting, for example, 1, 2, 4, 3, circle the alternative INCORRECT ORDER.

   c) If a student counts incorrectly in a manner different from omitting one number or ordering two numbers incorrectly, circle the alternative OTHER.

3. METHOD column. This column is used for collecting information about the types of methods the students may use to solve problems presented. Circle the alternative that best applies to the student's response. Two alternatives which are common to most of the method columns are IMMEDIATE and OTHER.

   a) IMMEDIATE. If a student responds to a question or statement within 3 seconds and it is difficult to discern the method or process used, circle IMMEDIATE.

   b) OTHER. If a student responds to a question or statement in a manner not described by the listed alternatives, circle OTHER. The examiner may want to elaborate on the "other" method or procedure used. To avoid a situation in which the student is forced to wait with no interaction, jot a brief note as a reminder beside OTHER and wait until the testing is complete before elaborating. After testing, describe the method or procedure in the COMMENTS section of the test form, using the numerical key to identify the item.

V. COMPLETION OF TESTING

Thank the student for participating. If the testing situation is one in which more than one student is being tested in the same room and the testing of other children is not complete, talk quietly with the student until all testing is completed. Walking around, game playing, or loud talking may disturb the testing of the other student(s).

VI. SCORING THE TEST

Write observations of the student's test behavior in the section labeled TEST BEHAVIOR. These obser-

vations should include the level of rapport, the confidence the examiner holds in the validity of the student's performance, or any unusual aspects of the student's performance which may have instructional significance.

In the section labeled COMMENTS, elaborate on those items requiring an explanation of the alternative OTHER. Indicate in this section those items in which the instructions or questions were unclear or ambiguous.

VII. DATA ANALYSIS INFORMATION

Record the student's PMDC ID number on the PMDC Record in the blank labeled STUDENT'S ID. Be sure that all the information on the PMDC Response Form is complete. Send the PMDC records to PMDC, Florida State University.

PMDC ARITHMETIC TEST, GRADE 1

STUDENT'S NAME _____ DATE _____

STUDENT RESPONSE FORM

STUDENT'S ID # _____ EXAMINER _____

1
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

2
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

3
No. Beans: No Attempt (6)

4
Response: No Attempt (4)

5
Response: No Attempt (9)

6
Response: No Attempt (14)

7
Response: No Attempt (Yes) / No

8
Response: No Attempt (Animals) / Cows / Neither/Same / Other

9
Response: No Attempt
Method: Immediate / Counted / Matched / Other

10
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

11
Response: No Attempt (Correct) ____ to
Errors: Skip Number / Incorrect Order / Other

12
No. Beans: No Attempt (Greater than 7)
Method: Counted / Matched / Gross / Other

13
Response: No Attempt (5)
Method: Immediate / Counted / Other

14
Horses: No Attempt (3)

15
Cows: No Attempt (7)

16
Animals: No Attempt (10)

17
Repeat All: No Attempt (10)

18
Response: No Attempt (Animals) / Cows / Other

19
Task Completed: Yes / No

20
Response: No Attempt (Same) / Not Same

21
Which One?: No Attempt / Small Beans / Large Beans

22
Response: No Attempt / Bean Size / One for One / Other

23
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

24
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

25
Constructed: No Attempt / Without Help / With Help / Incorrectly

26
Response: No Attempt (7)
Method: Immediate / Counted Stars / Other

27
Response: No Attempt (4)
Method: Immediate / Counted / Other

28
No. Beans: No Attempt (Less than 7)
Method: Counted / Matched / Gross / Other

29
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

30
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

31
Response: No Attempt (9)
Method: Immediate / Counted 1 9 / Counted On / Pointed / Other

32
Response: No Attempt (4)

33
Response: No Attempt (7)

34
Response: No Attempt (13)

35
Beans (1): No Attempt (3)

36
Beans (2): No Attempt (4)

37
Total Beans: No Attempt (7)
Method: Immediate / Count / Other

38
Square: Yes / No

39
Total Beans: No Attempt (7) / Other
Method: Immediate / Count / Other

40
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

41
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

42
No. Beans: No Attempt (8)
Method: Counted / Matched / Gross / Other

43
Response: No Attempt (2)
Method: Immediate / Counted / Other

44
Response: No Attempt (40)
Method: Immediate / Counted by Tens / Counted by Ones / Other
Response: No Attempt (40)

45

46
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

47
Response: No Attempt (Correct) ____ to ____
Errors: Skip Number / Incorrect Order / Other

48
No. Beans: No Attempt (16)
Method: Counted / Matched / Gross / Other

49
Response: No Attempt (4)

50
Response: No Attempt (8)

51
Response: No Attempt (15)

52
No. Beans: No Attempt (7)
Method: Counted / Matched / Gross / Other

53
Response: No Attempt (5)

Test Behavior _____ Comments _____

III. STUDENT RESPONSE FORMS

pmdc

PMDC ARITHMETIC TEST, GRADE 2

STUDENT RESPONSE FORM

STUDENT'S NAME _____ DATE _____

STUDENT'S ID # _____ EXAMINER _____

1

Response	Method
No Attempt (13)	Immediate Counting–touch Counting–visual Other

2

Response
No Attempt (2 3 5 9) 9 5 3 2 Other

3

Response
No Attempt (Yes) No

4

Response
No Attempt (Animals) Cows Neither/Same Other

5

Response	Method
No Attempt (6) Without beans	Counted On Counted 2, 4, then 6 Other

6

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

7

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

8

Response	Method
No Attempt (4) Without beans	Counted Back Counted 7, 3, then 4 Other

9

Horses
No Attempt (3)

10

Cows
No Attempt (7)

11

Animals
No Attempt (10)

12

Repeat All
No Attempt (10)

13

Response
No Attempt (Animals) Cows Other

14

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

15

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

16

Response
No Attempt (12)

17

Response
No Attempt (5 + 4)

18

Response
No Attempt (3 + 2)

19

Response
No Attempt (3 + 2)

20

Response	Method
No Attempt (6)	Immediate Subtracted Counted On Other

21

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

22

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

23

Response	Method
No Attempt (23) Without beans	Counted On Counted 18, 5, then 23 Other

24

Response
No Attempt (31)

25

Response
No Attempt (4 + 1)

26

Response
No Attempt (7 + 2)

27

Response
No Attempt (7 + 2)

28

Response	Method
No Attempt (16) Without Beans	Counted Back Counted 23, 7, then 16 Addition Other

29

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

30

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

31

Response
No Attempt (4)

32

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

33

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

34

Response	Method
No Attempt (24)	No Attempt Added Pattern Guessed Other

35

36

Response	Method
No Attempt (105)	No Attempt Added Pattern Guessed Other

37

38

Response	Method
No Attempt (5)	Immediate Subtracted Counted On Other

39

Response	Method
No Attempt (60)	Immediate Counts by Tens Counts by Ones Other

40

Written
No Attempt (37)

41

Verbal	Method	
No Attempt (37)	Immediate 10, 20, 30, 31, 32 30, 31, 32 1, 2, 3, 4 1, 2, 3, 4 10, 11, 12 Other	37 37 37 10 19

42

Response	Method
No Attempt (34)	Counted by Tens and Ones Counted by Ones Other

43

Response	Method
No Attempt (46)	Counted by Tens and Ones Counted by Ones Other

44

Response	Method
No Attempt (30)	Immediate Subtracted Counted On Other

45

Response	Method
No Attempt (50)	Immediate Counted by Tens Counted by Ones Other

46

Written
No Attempt (43)

47

Verbal	Method	
No Attempt (43)	Immediate 10, 20, 30, 40, 41, 42, 43 40, 41 1, 2, 3 1, 2 10, 11, 12 Other	43 43 7 16

48

Response	Method
No Attempt (37)	Counted by Tens and Ones Counted by Ones Other

49

Response	Method
No Attempt (52)	Counted by Tens and Ones Counted by Ones Other

50

Response	Method
No Attempt (20)	Immediate Subtracted Counted On Other

51

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

52

Response	Errors
No Attempt (Correct) ___ to ___	Skip Number Incorrect Order Other

Test Behavior _____

Comments _____

14

PART II: DESCRIPTION AND STATISTICAL PROPERTIES OF TESTS AND SCALES

IV. GRADE 1

SCORING THE GRADE 1 TEST AND SCALES

For all the scales in the fall testing the items were scored as follows:

Correct response
Incorrect response
No attempt

In order to give each item a right/wrong count, the information on the RESPONSE FORM (see p. 7) was summarized on the STUDENT PROFILE FORM. Only the information which was to be used in the statistical analysis was retained in the transfer from the RESPONSE FORM to the STUDENT PROFILE FORM. Information as to whether or not alternate instr ctions were necessary on rote counting items was not retained in the transfer. A copy of the STUDENT PROFILE FORM is provided in Appendix F.

In addition, the methods used to answer particular items were also recorded. A summary of the methods used is included together with each item of the test in Appendix B.

The actual scale score used in calculating the statistics in this report is the sum of correct responses for all items within the scale.

DESCRIPTIVE STATISTICS FOR PMDC GRADE 1 TEST

The PMDC Grade 1 Test is reproduced in Appendix B. The test consists of six scales which are described on the following pages. Statistics related to the total test scores are given below.

TEST STATISTICS:

NUMBER OF CASES	=	185
NUMBER OF ITEMS	=	39
MEAN TOTAL SCORE	=	22.886
STANDARD DEVIATION	=	8.626
CRONBACH'S ALPHA[4]	=	.925
ERROR OF MEASUREMENT	=	2.363

In addition to the Cronbach Alpha, the Spearman-Brown split-half estimate of reliability was also computed for the total PMDC Grade 1 Test and yielded a coefficient of .954.

CORRELATIONS WITH OTHER INSTRUMENTS:

PMDC Grade 1 Test vs. KeyMath Test:	.786
PMDC Grade 1 Test vs. Otis-Lennon Mental Ability Test:	.716

[4]See list of definitions in "Guide for the Use of This Volume," page viii.

GRADE 1

ELEMENTARY COUNTING (9 items)

Items in this scale are basically of three types: simple rote counting, counting picture sets, and constructing sets of a specified number. The item numbers and page references are listed below.

Items 2, 3, 11, 14, 15, 17, 35, 36, 47; Pages 22, 23, 25, 26, 26, 26, 31, 31, 33

SCALE STATISTICS:

NUMBER OF CASES	=	185
NUMBER OF ITEMS	=	9
MEAN TOTAL SCORE	=	7.305
STANDARD DEVIATION	=	2.068
CRONBACH'S ALPHA	=	.796
ERROR OF MEASUREMENT	=	.934

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
2	.561	.561	.416	.0
3	.777	.807	.601	3.7
11	.834	.839	.574	.5
14	.952	.957	.350	.5
15	.824	.828	.395	.5
17	.711	.715	.458	.5
35	.957	.968	.469	1.1
36	.947	.957	.573	1.1
47	.727	.731	.633	.5

ADVANCED COUNTING (4 items)

This scale is designed to measure the pupil's ability to perform advanced rote and rational counting tasks. The item numbers and page references are listed below.

Items 24, 30, 41, 45; Pages 27, 29, 31, 33

SCALE STATISTICS:

NUMBER OF CASES	=	185
NUMBER OF ITEMS	=	4
MEAN TOTAL SCORE	=	.808
STANDARD DEVIATION	=	1.180
CRONBACH'S ALPHA	=	.729
ERROR OF MEASUREMENT	=	.614

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
24	.198	.204	.475	3.2
30*	.273	.277	.378	1.6
41	.102	.104	.471	2.1
45	.235	.268	.480	12.3

*The response was scored as correct if the student counted to 100.

GRADE 1

ADDITION-SUBTRACTION (6 items)

This scale is composed of six tasks designed to measure the pupil's ability to solve addition and subtraction problems mentally and with manipulatives. The item numbers and page references are listed below.

Items 13, 27, 31, 37, 39, 43; Pages 26, 28, 30, 31, 31, 32

SCALE STATISTICS:

NUMBER OF CASES	-	185
NUMBER OF ITEMS	-	6
MEAN TOTAL SCORE	-	2.936
STANDARD DEVIATION	-	1.615
CRONBACH'S ALPHA	-	.644
ERROR OF MEASUREMENT	-	.964

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
13	.553	.581	.398	4.8
27	.362	.410	.323	11.7
31	.348	.365	.344	7.0
37	.723	.751	.359	3.7
39	.782	.808	.416	3.2
43	.154	.174	.395	11.2

SET EQUIVALENCE (8 items)

This scale is composed of items requiring the student to construct sets with more than, less than, one more than, one less than, and the same number of members as a given set as well as other equivalence-related tasks. The item numbers and page references are listed below.

Items 9, 12, 22, 26, 28, 42, 48, 52; Pages 24, 25, 27, 28, 29, 32, 34, 35

SCALE STATISTICS:

NUMBER OF CASES	-	185
NUMBER OF ITEMS	-	8
MEAN TOTAL SCORE	-	4.926
STANDARD DEVIATION	-	2.404
CRONBACH'S ALPHA	-	.794
ERROR OF MEASUREMENT	-	1.091

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
9	.681	.707	.560	3.7
12	.809	.826	.360	2.1
22	.590	.603	.357	3.7
26	.723	.751	.336	3.7
28	.590	.603	.601	3.7
42	.479	.514	.565	6.9
48	.367	.399	.591	8.0
52	.686	.721	.594	4.8

GRADE 1

ORDERING (10 items)

The items in this scale are of three types: Tell the number which comes just after a given number, tell the number which comes just before a given number, and tell the number which comes between two given numbers. The item numbers and page references are listed below.

Items 4, 5, 6, 32, 33, 34, 49, 50, 51, 53; Pages 23, 23, 23, 30, 30, 30, 34, 34, 34, 35

SCALE STATISTICS:

NUMBER OF CASES	=	185
NUMBER OF ITEMS	=	10
MEAN TOTAL SCORE	=	6.186
STANDARD DEVIATION	=	3.046
CRONBACH'S ALPHA	=	.858
ERROR OF MEASUREMENT	=	1.148

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
4	.910	.924	.275	1.6
5	.824	.852	.424	3.2
6	.723	.786	.444	8.0
32	.559	.577	.639	3.2
33	.537	.564	.676	4.8
34	.399	.439	.660	9.0
49	.628	.702	.602	10.6
50	.590	.677	.598	12.8
51	.367	.431	.557	14.9
53	.649	.744	.543	12.8

CLASS INCLUSION (2 items)

This scale is composed of two types of class inclusion problems. Item 8 is a classical class inclusion item, while item 18 requires that the pupil first count the members in each subset and in the total set. The item numbers and page references are listed below.

Items 8, 18; Pages 24, 26

SCALE STATISTICS:

NUMBER OF CASES	=	185
NUMBER OF ITEMS	=	2
MEAN TOTAL SCORE	=	.586
STANDARD DEVIATION	=	.775
CRONBACH'S ALPHA	=	*
ERROR OF MEASUREMENT	=	*

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
8	.245	.253	*	3.2
18	.339	.352	*	3.8

*Could not be computed due to small number of items (n=2).

V. GRADE 2

SCORING THE GRADE 2 TEST AND SCALES

For all the scales in the fall testing the items were scored as follows:

Correct response
Incorrect response
No attempt

In order to give each item a right/wrong count, the information on the RESPONSE FORM (see p. 8) was summarized on the STUDENT PROFILE FORM. Only the information which was to be used in the statistical analysis was retained in the transfer from the RESPONSE FORM to the STUDENT PROFILE FORM. Information as to whether or not alternate instructions were necessary on rote counting items was not retained in the transfer. A copy of the STUDENT PROFILE FORM is provided in Appendix F.

In addition, the methods used to answer particular items were also recorded. A summary of the methods used is included together with each item of the test in Appendix C.

The actual scale score used in calculating the statistics in this report is the sum of correct responses for all items within the scale.

DESCRIPTIVE STATISTICS FOR PMDC GRADE 2 TEST

The PMDC Grade 2 Test is reproduced in Appendix C. The test consists of nine scales which are described on the following pages. Statistics related to the total test scores are given below.

TEST STATISTICS:

NUMBER OF CASES	=	152
NUMBER OF ITEMS	=	42
MEAN TOTAL SCORE	=	22.358
STANDARD DEVIATION	=	9.804
CRONBACH'S ALPHA	=	.935
ERROR OF MEASUREMENT	=	2.490

In addition to the Cronbach Alpha, the Spearman-Brown split-half estimate of reliability was also computed for the total PMDC Grade 2 Test and yielded a coefficient of .932.

CORRELATIONS WITH OTHER INSTRUMENTS:

PMDC Grade 2 Test vs. Key Math Diagnostic Arithmetic Test:	.823
PMDC Grade 2 Test vs. Otis-Lennon Mental Ability Test:	.679

GRADE 2

ELEMENTARY COUNTING (7 items)

This scale is composed of items of two types: rote counting and counting picture sets. The item numbers and page references are listed below.

Items 1, 7, 9, 10, 12, 15, 22; Pages 38, 40, 41, 41, 41, 42, 44

SCALE STATISTICS:

NUMBER OF CASES	=	152
NUMBER OF ITEMS	=	7
MEAN TOTAL SCORE	=	6.138
STANDARD DEVIATION	=	1.074
CRONBACH'S ALPHA	=	.469
ERROR OF MEASUREMENT	=	.783

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
1	.671	.680	.206	1.3
7	.954	.960	.168	.7
9	.993	.993	*	.0
10	.947	.947	.019	.0
12	.862	.862	.176	.0
15	.816	.832	.311	2.0
22	.895	.901	.076	.7

*Could not be computed due to zero variance.

ADVANCED COUNTING (5 items)

The items of this scale are of basically two types: rote counting and determining the number of a set (multiple of ten) represented by place-value manipulatives. The item numbers and page references are given below.

Items 30, 33, 39, 45, 52; Pages 40, 48, 50, 53, 55

SCALE STATISTICS:

NUMBER OF CASES	=	152
NUMBER OF ITEMS	=	5
MEAN TOTAL SCORE	=	2.276
STANDARD DEVIATION	=	1.867
CRONBACH'S ALPHA	=	.820
ERROR OF MEASUREMENT	=	.492

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
30	.401	.407	.612	1.3
33	.289	.291	.526	.7
39	.526	.533	.697	1.3
45	.566	.585	.680	3.3
52*	.493	.507	.363	2.6

*The response was scored as correct if the student counted to 96.

GRADE 2

PATTERNS (2 items)

This scale is composed of two items, each requiring the pupil to solve an addition equation by using a related equation. The item numbers and page references are listed below.

Items 35, 37; Pages 49, 49

SCALE STATISTICS:

NUMBER OF CASES	=	152
NUMBER OF ITEMS	=	2
MEAN TOTAL SCORE	=	.533
STANDARD DEVIATION	=	.736
CRONBACH'S ALPHA	=	*
ERROR OF MEASUREMENT	=	*

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
35	.362	.505	*	28.3
37	.171	.295	*	42.1

*Could not be computed due to small number of items (n=2).

PLACE VALUE (8 items)

This scale is designed to measure the pupil's ability to determine the number of a place value set display and to construct such a set given a number orally or written. The item numbers and page references are listed below.

Items 40, 41, 42, 43, 46, 47, 48, 49; Pages 51, 51, 51, 52, 53, 53, 54, 54

SCALE STATISTICS:

NUMBER OF CASES	=	152
NUMBER OF ITEMS	=	8
MEAN TOTAL SCORE	=	3.730
STANDARD DEVIATION	=	3.414
CRONBACH'S ALPHA	=	.947
ERROR OF MEASUREMENT	=	2.462

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
40	.461	.493	.755	6.6
41	.454	.500	.760	9.2
42	.480	.575	.784	16.4
43	.513	.629	.816	18.4
46	.434	.471	.851	7.9
47	.447	.482	.884	7.2
48	.454	.535	.788	15.1
49	.487	.587	.807	17.1

GRADE 2

EQUIVALENT NAMES (6 items)

This scale is designed to measure the pupil's understanding of the concept of renaming, or supplying different names for the same number. The item numbers and page references are listed below.

Items 17, 18, 19, 25, 26, 27; Pages 43, 43, 43, 46, 46, 46

SCALE STATISTICS:

NUMBER OF CASES	=	152
NUMBER OF ITEMS	=	6
MEAN TOTAL SCORE	=	2.421
STANDARD DEVIATION	=	2.303
CRONBACH'S ALPHA	=	.876
ERROR OF MEASUREMENT	=	.812

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
17	.414	.453	.734	8.6
18	.441	.472	.744	6.6
19	.401	.445	.664	9.5
25	.408	.431	.613	5.3
26	.480	.521	.668	7.9
27	.276	.286	.652	3.3

ORDERING (4 items)

This scale is designed to measure the pupil's ability to order a set of 4 one-digit numbers and to tell which of two numbers is more or less. The item numbers and page references are listed below.

Items 2, 16, 24, 31; Pages 39, 42, 45, 48

SCALE STATISTICS:

NUMBER OF CASES	=	152
NUMBER OF ITEMS	=	4
MEAN TOTAL SCORE	=	3.026
STANDARD DEVIATION	=	.966
CRONBACH'S ALPHA	=	.471
ERROR OF MEASUREMENT	=	.703

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
2	.770	.775	.275	.7
16	.974	.983	.113	.7
24	.464	.980	.333	1.3
31	.822	.855	.322	4.6

GRADE 2

ADDITION-SUBTRACTION (4 items)

This scale is composed of two addition problems and two subtraction problems and requires the pupil to use counters to solve the problems. The item numbers and page references are listed below.

Items 5, 8, 23, 28; Pages 40, 41, 45, 47

SCALE STATISTICS:

NUMBER OF CASES	=	152
NUMBER OF ITEMS	=	4
MEAN TOTAL SCORE	=	2.559
STANDARD DEVIATION	=	1.206
CRONBACH'S ALPHA	=	.604
ERROR OF MEASUREMENT	=	.759

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
5	.901	.919	.290	2.0
8	.618	.623	.450	.7
23	.651	.673	.293	3.3
28	.388	.421	.456	7.9

MISSING ADDEND (4 items)

This scale is composed of four items designed to measure the pupil's ability to give a verbal answer to missing addend problems. The item numbers and page references are listed below.

Items 20, 38, 44, 50; Pages 44, 50, 52, 55

SCALE STATISTICS:

NUMBER OF CASES	=	152
NUMBER OF ITEMS	=	4
MEAN TOTAL SCORE	=	.987
STANDARD DEVIATION	=	1.201
CRONBACH'S ALPHA	=	.683
ERROR OF MEASUREMENT	=	.676

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
20	.388	.461	.589	15.8
38	.263	.351	.532	25.0
44	.243	.370	.500	34.2
50	.092	.161	.272	42.8

GRADE 2

CLASS INCLUSION (2 items)

This scale is composed of two types of class inclusion problems. Item 4 is the classical class inclusion problem, while Item 13 requires the pupil first to count the members of each subset and the total set before answering the class inclusion question. The item numbers and page references are listed below.

Items 4, 13; Pages 39, 41

SCALE STATISTICS:

NUMBER OF CASES	=	152
NUMBER OF ITEMS	=	2
MEAN TOTAL SCORE	=	717
STANDARD DEVIATION	=	.8[illegible]5
CRONBACH'S ALPHA	=	*
ERROR OF MEASUREMENT	=	*

ITEM STATISTICS:

ITEM	P's	ADJ. P's	N. S. BIS	PERCENT NT
4	.283	.303	*	6.6
13	.434	.443	*	2.0

*Could not be computed due to small number of items (n=2).

APPENDIX A

TABLE 1
SUMMARY OF DATA ON SCHOOL SIZE

Variable	School 1	2	3	4	5
Grade levels	K-5	K-12	K-5	1-5	1-5
Approximate number of students	350	900	350	380	420

TABLE 2
DESCRIPTIVE STATISTICS OF SAMPLE BY SCHOOL AND GRADE

	Sex M	F	Mean Age (mos.)	Mean PMDC Test	Mean DIQ*	Grade Equivalent Mean KM†
Grade 1				(39 items)		
School 1	15	18	75.3	19.1	88.8	1.0
School 2	12	13	74.6	25.7	111.5	1.5
School 3	34	34	76.1	23.2	104.5	1.2
School 4	36	35	76.2	23.3	100.2	1.4
Total	97	100	75.8	22.9	101.1	1.3
Grade 2				(42 items)		
School 1	18	13	87.2	15.2	91.1	1.8
School 2	13	12	87.8	28.1	116.8	2.7
School 3	8	4	90.5	21.1	105.8	2.0
School 4	25	25	89.1	20.0	99.6	2.1
School 5	17	23	88.7	27.2	113.1	2.6
Total	81	77	88.5	22.4	104.6	2.3

*Deviation IQ (See Appendix D, page 57).

†KeyMath (See Appendix E, page 59).

APPENDIX B

Appendix B is a composite of the PMDC Mathematics Test: Grade One and the statistical results of the test, so arranged for the reader's convenience that each page of this publication represents two consecutive pages of the actual PMDC Mathematics Test: Grade One questions, with the student stimuli material superimposed in a box at the top of each page and the statistical results for the items presented in a box below.

To obtain both the PMDC Mathematics Test: Grade One and the Examiner's Manual, write to:

Dr. Eugene D. Nichols
Florida State University
Tallahassee, Florida 32306

PROJECT FOR THE MATHEMATICAL DEVELOPMENT

OF CHILDREN

MATHEMATICS TEST: GRADE ONE

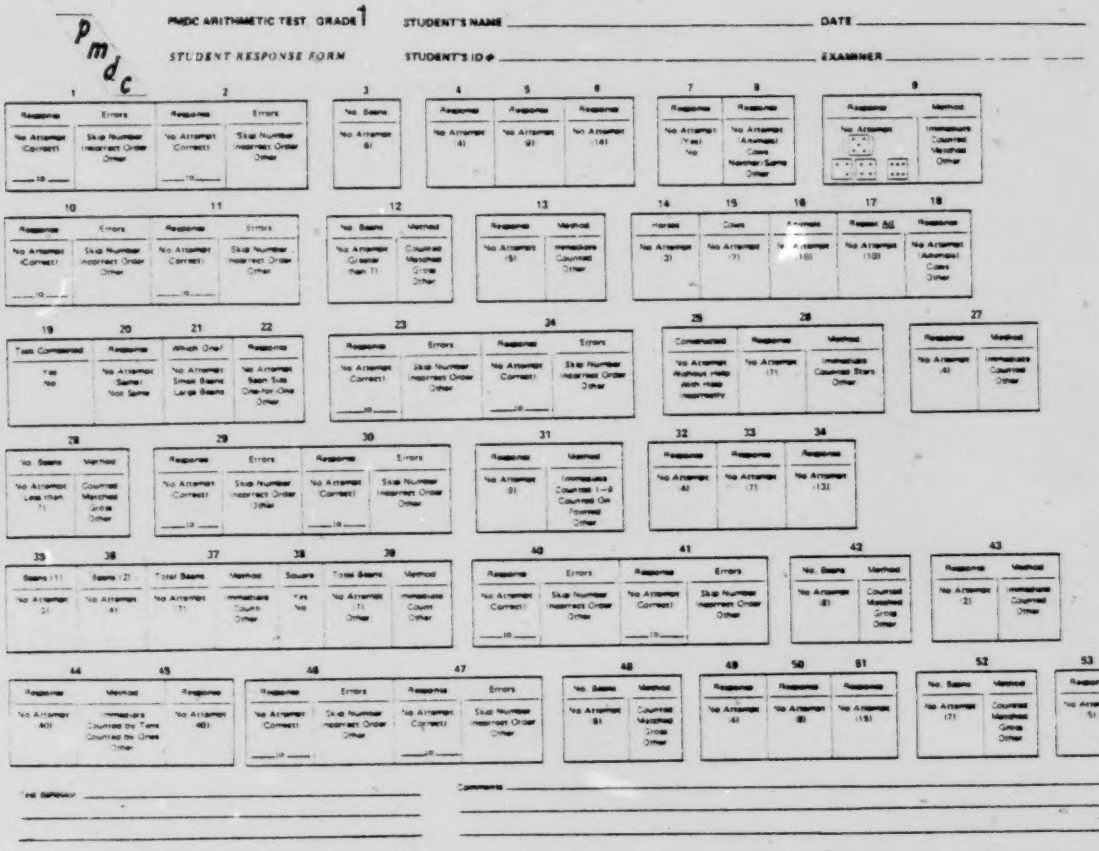
Financial support for the Project for the Mathematical Development of Children has been provided by the National Science Foundation: Grant No. PES 74-18106-A03.

TO THE USER

The PMDC Mathematics Test: Grade One was pilot-tested during July 1975. The test was then revised and administered during the first three weeks of September 1975 to 197 students. The test in this packet is the latter test. The user may reproduce any of the materials in this packet without obtaining permission from PMDC. Those persons who use the PMDC Mathematics Test: Grade One are encouraged to share with the PMDC staff their evaluation of the test and the data they collect. Such correspondence should be addressed to:

Dr. Eugene D. Nichols
Florida State University
Tallahassee, Florida 32306

Instructions for administering the test and summaries of pertinent statistical analyses are included in the accompanying Examiner's Manual. More detailed analyses of the data obtained from the 1975 Fall Testing Program reported in PMDC Technical Reports Nos. 2 and 3. Information about these publications may be obtained by writing to the above address.



1. Say	COUNT FOR ME. ①
2. If no response, say	I WANT YOU TO COUNT LIKE THIS. ONE, TWO, THREE. NOW YOU DO IT. ②
3. If the student stops before 35, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 35 or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
Counted to 35	56.1
Counted to 29	16.6
Counted to 19	12.8
Counted to 10	9.6
Other response	4.8

Note: 2.0% required second instructions.

6

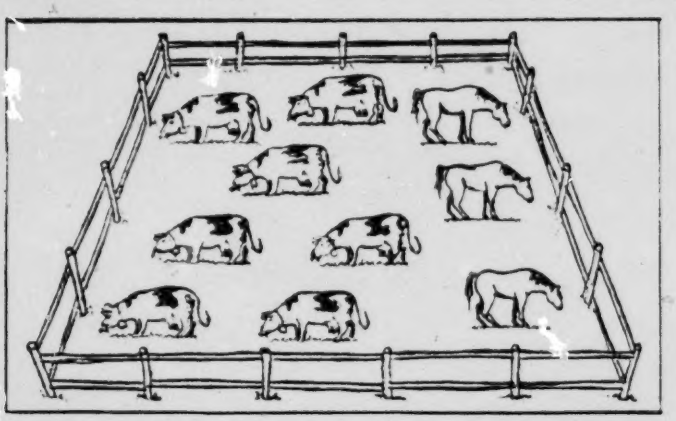
1. Place 50 beans to the student's right. Point to the numeral and say:	MAKE A SET WHICH HAS THIS MANY BEANS. ③

Materials: 50 beans

Response	Percent
No attempt	3.7
Used 6 beans correctly	78.2
Used beans to make a numeral 6	3.7
Other error	14.4

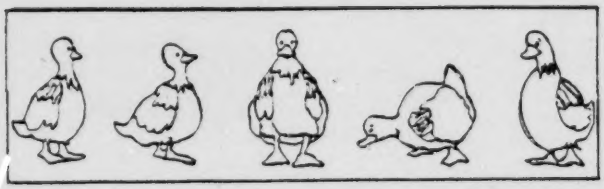
1. Ask	WHAT NUMBER COMES JUST AFTER 3? ④
2. Ask	WHAT NUMBER COMES JUST AFTER 8? ⑤
3. Ask	WHAT NUMBER COMES JUST AFTER 13? ⑥

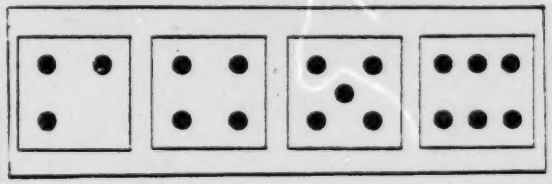
Response	Percent	Response	Percent	Response	Percent
4. No attempt	1.6	5. No attempt	3.2	6. No attempt	8.0
4	91.0	9	82.4	14	72.3
2	2.7	7	2.7	15	3.7
Other	4.8	Other	11.7	6	1.1
				Other	14.9



1. Point to the picture. Ask (If the student responds "No", do not continue this item.)	ARE ALL THE COWS ANIMALS? ⑦
2. Ask	ARE THERE MORE ANIMALS OR MORE COWS? ⑧

Response	Percent
No attempt	3.2
No attempt to item 7 or "No" to item 7, item 8 not administered	1.1
Animals (correct)	24.5
Cows	69.7
Other incorrect	1.6





1. Hand the student the card with five ducks. Say	HERE ARE SOME DUCKS.
2. Point to the pictures of dots. Ask	WHICH OF THESE SHOWS HOW MANY DUCKS? ⑨

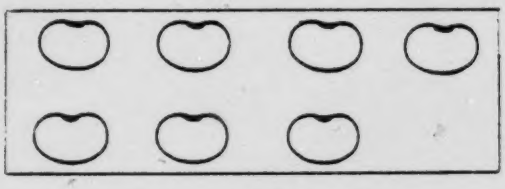
Materials: Card with 5 ducks.

Response	Method	Percent
No attempt		3.7
5 dots	Counted ducks, then dots	42.0
5 dots	Other, no evidence of counting	26.0
6 dots		16.5
Other error		11.7

1. Say	START AT SIX AND COUNT FOR ME. (10)
2. If no response or starts at one, say	I WANT YOU TO COUNT LIKE THIS. 6,7, 8. NOW YOU DO IT. (11)
3. If the student stops before 15, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 15 or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
No attempt	3.2
Counted to 15	83.4
Counted to 10	7.5
Counted to 8	3.2
Other	2.6

Note: 27.3% required second instructions.



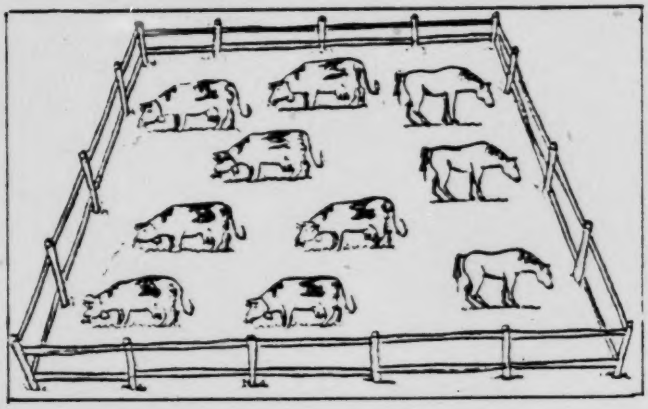
Put a pile of 30 beans to the student's right.	
1. Point to the picture. Say	THIS IS A PICTURE OF SOME BEANS.
2. Point to a clear space in front of the student. Say	MAKE A SET WHICH HAS MORE BEANS THAN THE PICTURE. (12)

Materials: 30 beans

Response	Method	Percent
No attempt		2.1
Greater than 7	Counted beans in picture, then counted beans	38.8
Greater than 7	Matched one-for-one, then added more beans	5.9
Greater than 7	Gross, selected large number of beans without counting	26.1
Greater than 7	Other	10.1
Less than 7	Counted beans in picture, then counted beans	4.8
Less than 7	Other	6.4
Exactly 7	Counted	6.4
Exactly 7	Matched	1.6

1. Say	I AM GOING TO READ A STORY. I'LL ASK YOU A QUESTION. YOU ANSWER THE QUESTION.
2. Say (Repeat story, if necessary.)	I HAVE THREE PENCILS. YOU HAVE TWO PENCILS. HOW MANY PENCILS DO WE HAVE TOGETHER? (13)

Response	Method	Percent
No attempt		4.8
5	Counted	23.4
5	Other, no evidence of counting	14.4
5	Immediate	17.6
4		13.3
Incorrect	Other	26.6



1. Point to the picture. Say	COUNT THE HORSES. (14)
2. Say	COUNT THE COWS. (15)
3. Say	COUNT THE ANIMALS. (16)
4. If the student does not count <u>all</u> the animals, say	COUNT <u>ALL</u> THE ANIMALS. (17)
5. Say	ARE THERE MORE ANIMALS OR MORE COWS? (18)

14. Response	Percent
No attempt	.5
Responded 3	95.2
Responded 10	2.1
Responded 7	.5
Other incorrect	1.6

15. Response	Percent
No attempt	5
7	82.4
10	.5
3	.5
Other incorrect	16.0

16, 17. Response	Percent
No attempt to item 16	.5
No attempt to items 16 and 17	1.6
Responded "10" to item 16	48.1
Responded "10" to item 17	23.0
Other to item 16	16.0
Other to item 17	10.7

18. Response	Percent
No attempt	3.8
Animals (correct)	33.9
Cows	62.4

1. Give the student a box, say	HERE IS A BOX FOR YOU TO USE.
2. Point to the other box, say	THIS IS MY BOX.
3. Place the 9 large beans in a pile next to the student's box. Say	HERE ARE SOME BEANS FOR YOU TO USE.
4. Put the 9 small beans next to your box. Say	I'LL USE THESE BEANS.
5. As you put a bean in your box, say	I'LL PUT ONE BEAN IN MY BOX, AND YOU PUT A BEAN IN YOUR BOX.
6. As you put the second bean in your box, say	I'LL PUT ANOTHER BEAN IN MY BOX AND YOU PUT A BEAN IN YOUR BOX.
7. As you put the third bean in your box, say	LET'S DO IT AGAIN.
8. Continue without verbal directions until all 9 beans are used. But, if a student doesn't follow suit, say	NOW YOU PUT A BEAN IN YOUR BOX. (19)
9. Say	DO BOTH BOXES HAVE THE SAME NUMBER OF BEANS OR DOES ONE BOX HAVE MORE BEANS? (20)
10. If the student says one box has more but does not indicate which has more, ask	WHICH ONE? (21)
11. Ask	HOW DO YOU KNOW? (22)

Materials: 2 boxes, 9 large beans, 9 small beans

Response to 20	Response to 22	Percent
No attempt		3.7
Same number	One-to-one	17.0
Same number	Other reason, e.g., "I counted."	29.8
Same number	No reason	11.7
Not same	More large beans	20.7
Not same	More small beans	5.9
Not same	Other reason, e.g., "I got more."	9.5
Not same	No reason	1.6

1. Say	START AT 90 AND COUNT FOR ME. (23)
2. If no response or starts at one, say	I WANT YOU TO COUNT LIKE THIS. 90, 91, 92. NOW YOU DO IT. (24)
3. If the student stops before 112, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 112 or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
No attempt	10.2
Counted to 112	19.8
Counted to 99	47.0
Counted to 92	15.5
Other response	7.5

Note: 52% required second instructions.

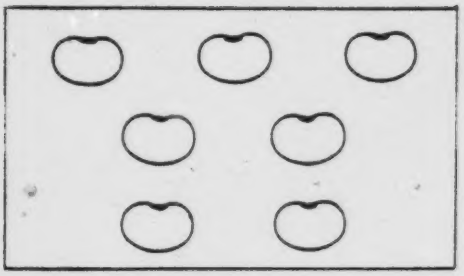
Place the card with 7 stars on it in front of the student. Say 1. Place 50 beans to the student's right. Say	HERE IS A PICTURE OF SOME STARS. HERE ARE SOME BEANS. PUT A BEAN ON EACH STAR. (25)
2. If the student does it incorrectly, place two beans on two stars and say If the student still cannot do it correctly, say	NOW YOU DO THE REST. SEE, I AM PUTTING A BEAN ON EACH STAR.
3. Sweep the beans off the stars and cover the pile of beans with your hand. Ask	HOW MANY BEANS DO I HAVE UNDER MY HAND? (26)

Materials: Card with 7 stars
50 beans

Response	Method	Percent
No attempt		3.7
7	Counted stars	51.6
7	Other	20.8
Incorrect	Counted stars	9.6
Incorrect	Other	14.4

1. Say	I AM GOING TO READ A STORY. I'LL ASK YOU A QUESTION. YOU ANSWER THE QUESTION.
2. Say (Repeat story, if necessary.)	I HAD SEVEN TOY CARS. YOU TOOK THREE TOY CARS. HOW MANY TOY CARS DO I HAVE NOW? (27)

Response	Method	Percent
No attempt		11.7
4	Counted	17.6
4	Other	18.6
Incorrect	Immediate	20.7
Incorrect	Counted	9.6
Incorrect	Other	13.3



Put a pile of 50 beans to the student's right. 1. Point to the picture. Say	THIS IS A PICTURE OF SOME BEANS.
2. Point to a clear space in front of the student. Say	MAKE A SET WHICH HAS LESS BEANS THAN THE PICTURE. (28)

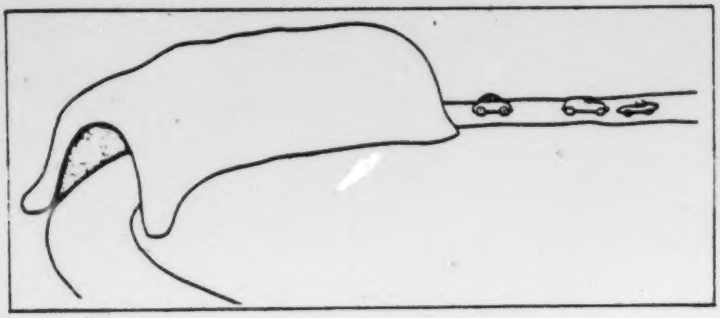
Materials: 50 beans

Response	Method	Percent
No attempt		3.7
Less than 7	Counted beans in picture, then counted beans	31.9
Less than 7	Matched one-for-one, but did not match all beans	5.3
Less than 7	Gross, selected small number of beans without counting	9.6
Less than 7	Other	12.2
Exactly 7		11.2
8 or more		25.5

1. Say	COUNT BY TENS FOR ME. (29)
2. If no response or if the student counts by ones, say	I WANT YOU TO COUNT LIKE THIS. TEN, TWENTY, THIRTY. NOW YOU DO IT. (30)
3. If the student stops before 130, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 130 or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
No attempt	23.0
Counted to 100	27.3
Counted to 50	23.5
Counted to 30	13.9
Other	12.3

Note: 82.4% required second instructions.

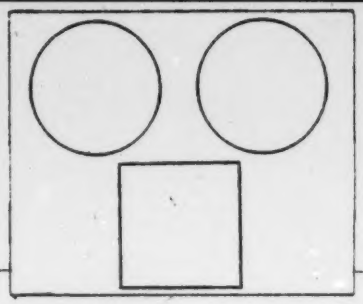


1. Point to the tunnel, say	THIS IS A TUNNEL.
2. Make a sweeping motion, pointing to the cars then the tunnel, while saying Ask	THERE ARE THREE CARS OUTSIDE THE TUNNEL, AND THERE ARE SIX CARS STILL IN THE TUNNEL. HOW MANY CARS ARE THERE ALL TOGETHER? (31)

Response	Method	Percent
No attempt		7.0
9	Counted 1-9	15.5
9	Counted on	9.1
9	Pointed	1.1
9	Other	9.1
Incorrect	Counted on	3.7
Incorrect	Pointed	3.7
Incorrect	Other	50.8

1. Ask	WHAT NUMBER COMES JUST BEFORE 5? (32)
2. Ask	WHAT NUMBER COMES JUST BEFORE 8? (33)
3. Ask	WHAT NUMBER COMES JUST BEFORE 14? (34)

Response	Percent				
32. No attempt	3.2	33. No attempt	4.8	34. No attempt	9.0
4	55.9	7	53.7	13	39.9
6	32.4	9	31.4	15	24.5
Other	8.5	Other	10.1	Other	26.6



1. Place the card in front of the student with the two circles closest to the student. Put 50 beans beside the card. Say Point to the circle on your left. Say (If the student places other than three beans in the circle, do not correct him. Record the number of beans placed.)	HERE ARE SOME BEANS FOR YOU TO USE. PUT THREE BEANS IN THIS CIRCLE. (35)
2. Point to the other circle, say (If the student places other than four beans in the circle, do not correct him. Record the number of beans placed.)	PUT FOUR BEANS IN THIS CIRCLE. (36)
3. Ask	HOW MANY BEANS ALL TOGETHER? (37)
4. Point to the square. If student does not respond, move beans inside square and say	PUT ALL THE BEANS IN THE SQUARE. (38) NOW ALL THE BEANS ARE INSIDE THE SQUARE.
5. Ask	HOW MANY BEANS ARE IN THE SQUARE? (39)

	Response	Method	Percent
35.	No attempt		1.1
	3		95.7
	Other		3.2
36.	No attempt		1.1
	4		94.7
	Other		4.3

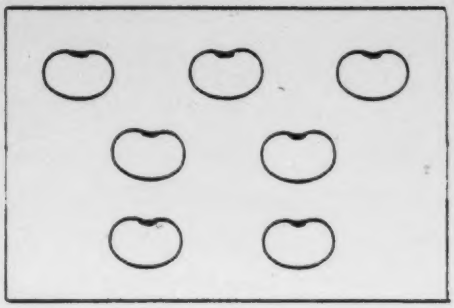
	Response	Method	Percent
37	No attempt		3.7
	7	Counted	56.4
	7	Other	16.0
	Incorrect	Counted	12.2
	Incorrect	Other	11.7

	Response	Method	Percent
39.	No attempt		3.2
	7	Immediate	43.4
	7	Counted	31.9
	Not 7	Immediate, but same as item 37	3.2
	Incorrect	Immediate	7.9
	Incorrect	Counted	8.5
	Incorrect	Other	2.1

1. Say	COUNT BY 2'S FOR ME. (40)
2. If counts by 1's or no response, say	I WANT YOU TO COUNT LIKE THIS. TWO, FOUR, SIX. NOW YOU DO IT. (41)
3. If the student stops before 20, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 20 or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
No attempt	24.0
Counted to 20	10.2
Counted to 10	12.3
Counted to 6	44.9
Other	8.6

Note: 77.9% required second instructions.



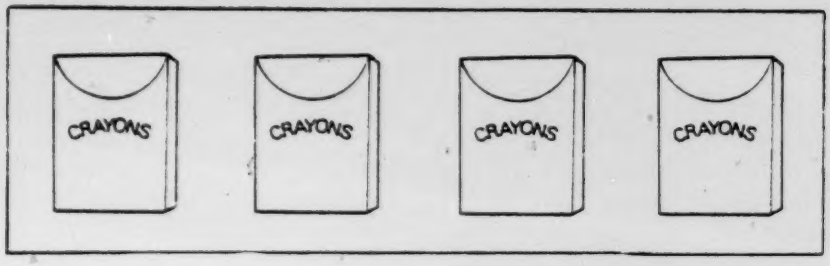
Put a pile of 50 beans to the student's right. 1. Point to the picture. Say	THIS IS A PICTURE OF SOME BEANS.
2. Point to a clear space in front of the student. Say	MAKE A SET WHICH HAS ONE MORE BEAN THAN THE PICTURE. (42)

Materials: 50 beans

Response	Method	Percent
No attempt		6.9
8	Counted beans in picture, then counted beans	34.0
8	Matched one-for-one, then added one more	7.4
8	Other	6.4
More than 8		21.3
Other incorrect		24.0

1. Say	I AM GOING TO READ A STORY. I'LL ASK YOU A QUESTION. YOU ANSWER THE QUESTION.
2. Say (Repeat story, if necessary.)	TOGETHER WE HAVE SIX PENNIES. YOU HAVE FOUR PENNIES. HOW MANY PENNIES DO I HAVE? (43)

Response	Method	Percent
No attempt		11.2
2	Counted	5.3
2	Other	10.1
6	Immediate	27.7
Other incorrect		45.8



1. Point to each box and say	THERE ARE 10 CRAYONS IN THIS BOX. THERE ARE 10 CRAYONS IN THIS BOX. THERE ARE 10 CRAYONS IN THIS BOX. THERE ARE 10 CRAYONS IN THIS BOX. HOW MANY CRAYONS ARE THERE ALL TOGETHER? (44)
2. If no response, or the student counts by ones, say	COUNT THEM BY TENS. (45)

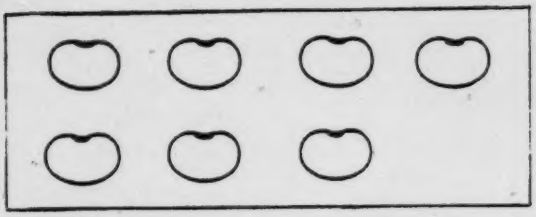
Response	Method	Percent
No attempt		26.7
40	Counted by tens	19.3
40	Other	4.3
4	Counted by ones	3.2
Other incorrect		46.5

Note: 36.2% required second instructions.

1. Say	START AT SIX AND COUNT BACKWARDS FOR ME. (46)
2. If no response, say	I WANT YOU TO COUNT LIKE THIS. 6, 5, 4. NOW YOU DO IT. (47)
3. If the student stops before 1, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 1 or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
No attempt	11.7
Counted down to 1 or 0	72.8
Counted down to 4	10.7
Other response	4.8

Note: 35.3% required second instructions.



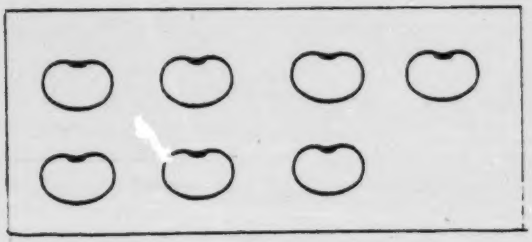
Put a pile of 50 beans to the student's right. 1. Point to the picture. Say	THIS IS A PICTURE OF SOME BEANS.
2. Point to a clear space in front of the student. Say	MAKE A SET WHICH HAS ONE LESS BEAN THAN THE PICTURE. (48)

Materials: 50 beans

Response	Method	Percent
No attempt		8.0
6	Counted beans in picture, then counted out one less bean	27.1
6	Matched one-for-one, leaving out one bean	5.9
6	Other	3.7
Incorrect		55.3

1. Ask	WHAT NUMBER COMES BETWEEN 3 AND 5? (49)
2. Ask	WHAT NUMBER COMES BETWEEN 7 AND 9? (50)
3. Ask	WHAT NUMBER COMES BETWEEN 14 AND 16? (51)

Response	Percent	Response	Percent	Response	Percent
49. No attempt	10.6	50. No attempt	12.8	51. No attempt	14.9
4	62.8	8	59.0	15	36.7
6	14.4	10	15.4	17	28.2
3 or 5	1.1	7 or 9	.5	14 or 16	1.6
Other	11.2	Other	12.2	Other	18.6



Put a pile of 50 beans to the student's right. 1. Point to the picture. Say	THIS IS A PICTURE OF SOME BEANS.
2. Point to clear space in front of the student. Say	MAKE A SET THAT HAS THE SAME NUMBER OF BEANS AS THE PICTURE. (52)

Materials: 50 beans

Response	Method	Percent
No attempt		4.8
7	Counted beans in picture, then counted beans	40.4
7	Matched one-for-one	21.3
7	Other	6.9
Incorrect	Counted beans in picture, then counted beans	7.4
Incorrect	Gross, selected large number of beans without counting	4.8
Incorrect	Other	14.4

1. Ask	WHAT NUMBER COMES BETWEEN 6 AND 4? (53)

Response	Percent
No attempt	12.8
5	64.9
7	8.5
3	1.1
6 or 4	1.6
Other	11.2

APPENDIX C

Appendix C is a composite of the PMDC Mathematics Test: Grade Two and the statistical results of the test, so arranged for the reader's convenience that each page of this publication represents two consecutive pages of the actual PMDC Mathematics Test: Grade Two questions, with the student stimuli material superimposed in a box at the top of each page and the statistical results for the items presented in a box below.

To obtain both the PMDC Mathematics Test: Grade Two and the Examiner's Manual, write to:

Dr. Eugene D. Nichols
Florida State University
Tallahassee, Florida 32306

PROJECT FOR THE MATHEMATICAL DEVELOPMENT

OF CHILDREN

MATHEMATICS TEST: GRADE TWO

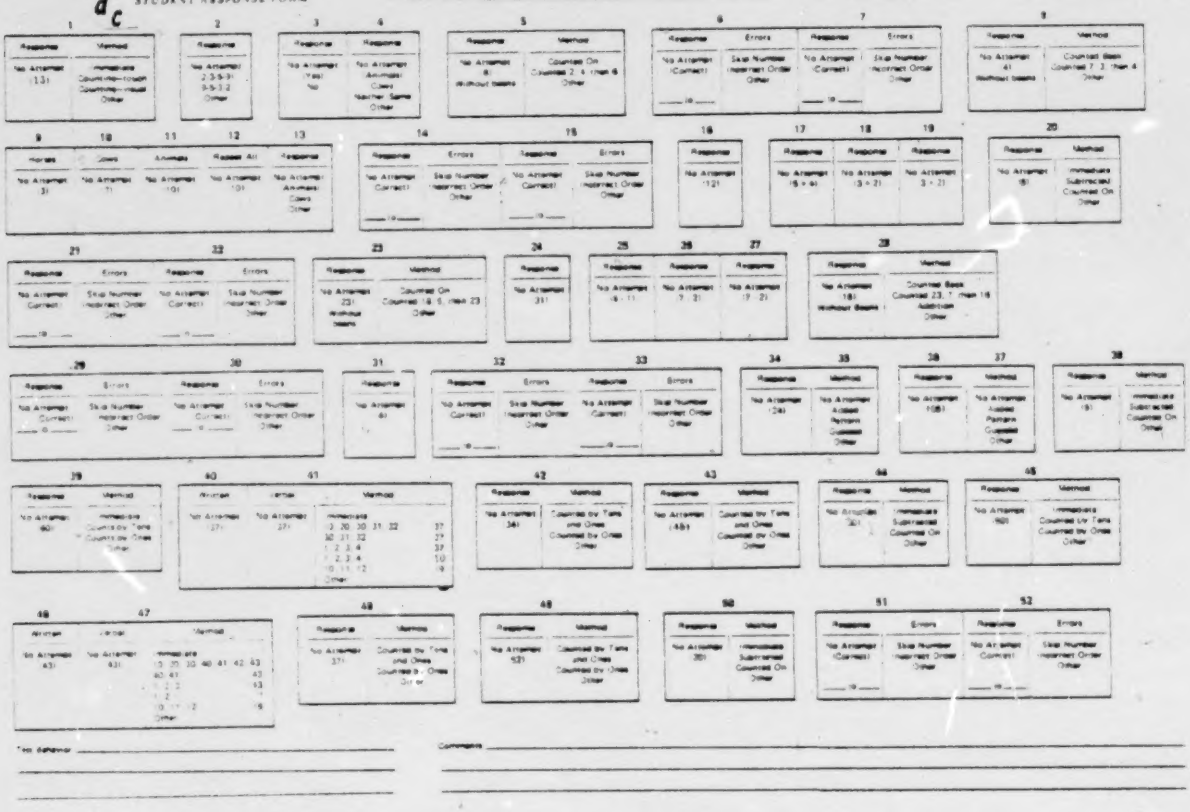
Financial support for the Project for the Mathematical Development of Children has been provided by the National Science Foundation: Grant No. PES 74-18106-A03.

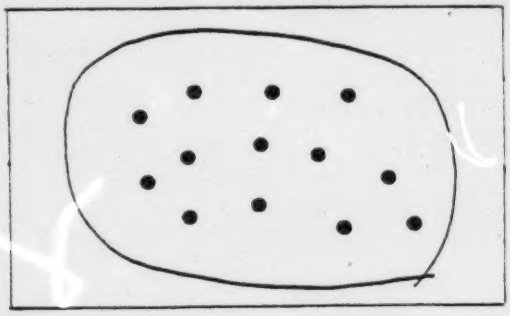
TO THE USER

The PMDC Mathematics Test: Grade Two was pilot-tested during July 1975. The test was then revised and administered during the first three weeks of September 1975 to 158 students. The test in this packet is the latter test. The user may reproduce any of the materials in this packet without obtaining permission from PMDC. Those persons who use the PMDC Mathematics Test: Grade Two are encouraged to share with the PMDC staff their evaluation of the test and the data they collect. Such correspondence should be addressed to:

Dr. Eugene D. Nichols
Florida State University
Tallahassee, Florida 32306

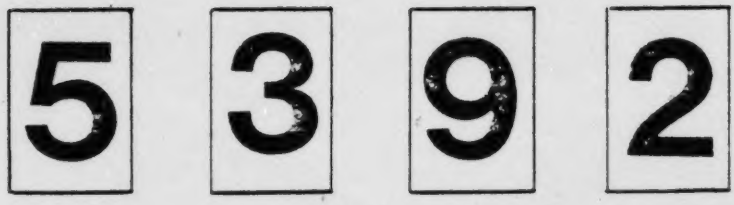
Instructions for administering the test and summaries of the pertinent statistical analyses are included in the accompanying Examiner's Manual. More detailed analyses of the data obtained from the 1975 Fall Testing Program are reported in PMDC Technical Reports Nos. 2 and 3. Information about these publications may be obtained by writing to the above address.





1. Point to the dots, ask HOW MANY DOTS ARE THERE? ①

Response	Method	Percent
No attempt		1.3
Correct	Immediate	4.0
Correct	Touch counting	22.4
Correct	Visual counting	40.8
Incorrect	Immediate	2.0
Incorrect	Touch counting	5.9
Incorrect	Visual counting	23.7



1. Hand the student the cards, stacked face up from top to bottom in this order:

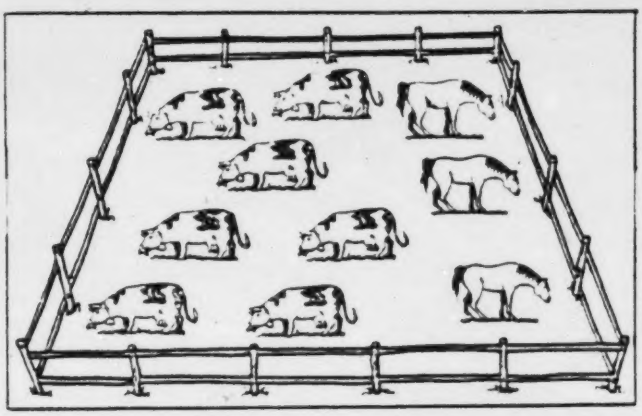
   5, 3, 9 and 2. Say

PUT THESE IN ORDER FROM SMALLEST TO LARGEST. ③

Materials:

Four cards with the numerals 2, 3, 5, and 9 on them

Response	Percent
No attempt	4.4
2, 3, 5, 9	74.1
Incorrect—9, 5, 3, 2	6.3
Incorrect—other	15.2



1. Point to the picture. Ask

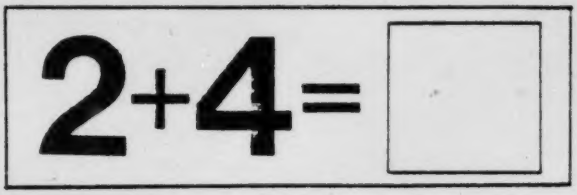
   If student responds "NO," do not continue this item.

ARE ALL THE COWS ANIMALS? ③

2. Ask

ARE THERE MORE ANIMALS OR MORE COWS? ④

Response	Percent
No attempt to item 3, or No to item 3 (item 4 not administered)	10.1
Animals (correct)	27.2
Cows	59.5
Same number of each	1.9
Incorrect	1.3



Place 50 beans in front of the student. Point to the problem, say	USE THE BEANS TO FIND THE ANSWER TO THE PROBLEM. ③
If the student verbalizes the answer, but does not use the beans, say	NOW SHOW ME HOW TO USE THE BEANS TO FIND THE ANSWER.
If the student uses the beans, but does not verbalize the answer, ask	WHAT IS THE ANSWER?

Materials:

50 beans

Response	Method	Percent
No attempt		2.0
Correct	Answered 6 without using beans	11.2
Correct	Used beans to construct equation 2 + 4 = 6 (made 3 sets)	65.1
Correct	Counted 2, 4, then 6	1.3
Correct	Counted on	7.9
Correct	Other	4.6
Incorrect	Attempted to count 2, 4, then 6	4.6
Incorrect	Other	3.3

1. Say	START AT SIX AND COUNT FOR ME. ⑤
2. If no response or starts at one, say	I WANT YOU TO COUNT LIKE THIS. 6, 7, 8. NOW YOU DO IT. ⑦
3. If the student stops before 15, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 15 or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
No attempt	7
Counted to 15	95.4
Counted to 10	1.3
Counted to 8	.7
Other incorrect response	2.0

Note: 13.8% required second instructions.

7 − 3 = ☐

Place 50 beans in front of the student.

1. Point to the problem. Say

USE THE BEANS TO FIND THE ANSWER. (8)

If the student verbalizes the answer, but does not use the beans or just shows the answer with the beans, say

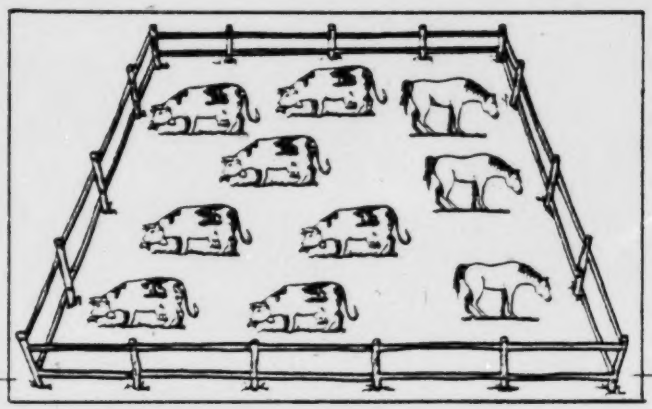
NOW SHOW ME HOW TO USE THE BEANS TO FIND THE ANSWER.

If the student uses the beans, but does not verbalize the answer, ask

WHAT IS THE ANSWER?

Materials: 50 beans

Response	Method	Percent
No attempt		.7
Correct	Counted back	3.3
Correct	Counted 7, 3, then 4	51.3
Correct	Without beans	5.3
Correct	Other	2.0
Incorrect	Addition	26.3
Incorrect	Attempted to count 7, 3, then 4	3.9
Incorrect	Other	7.3



1. Point to the picture. Say

COUNT THE HORSES. (9)

2. Say

COUNT THE COWS. (10)

3. Say

COUNT THE ANIMALS. (11)

4. If the student omits a subset, say

COUNT ALL THE ANIMALS. (12)

5. Ask

ARE THERE MORE ANIMALS OR MORE COWS? (13)

Response	Percent
9. 3 (Correct)	99.3
Incorrect	.7
10. 7 (Correct)	94.7
Incorrect	5.3

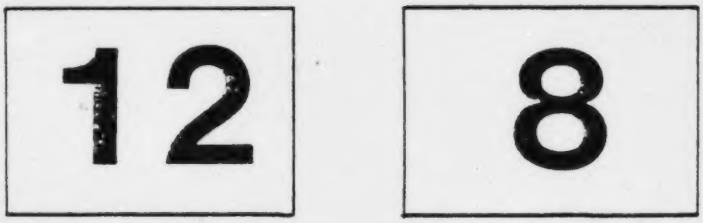
Response	Percent
11, 12. 10, item 11	73.0
10, item 12	13.2
Incorrect, item 11	2.6

Response	Percent
13. No attempt	5.7
Animals (correct)	41.8
Cows	51.9
Same number of each	.6

1. Say	START AT 35 AND COUNT FOR ME. (14)
2. If no response or if the student starts at 1, say	I WANT YOU TO COUNT LIKE THIS. THIRTY-FIVE, THIRTY-SIX, THIRTY-SEVEN. NOW YOU DO IT. (15)
3. If the student stops before 46, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 46, or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

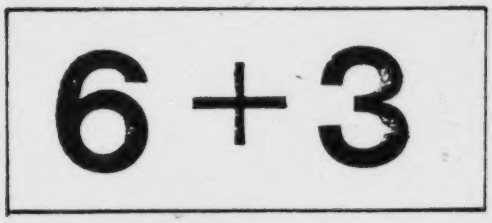
Response	Percent
No attempt	1.9
Counted to 46	81.6
Counted to 39	14.5
Counted to 37	.7
Other response	1.4

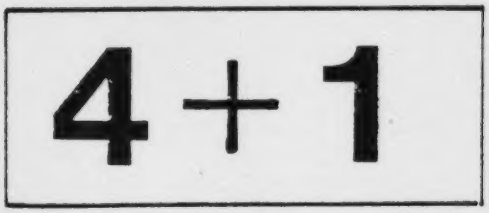
Note: 21.1% required second instructions.



1. Point to numerals, ask	WHICH IS MORE? (16)

Response	Percent
No attempt	.7
Correct	97.4
Incorrect	2.0





Cards examiner holds up

Cards facing student

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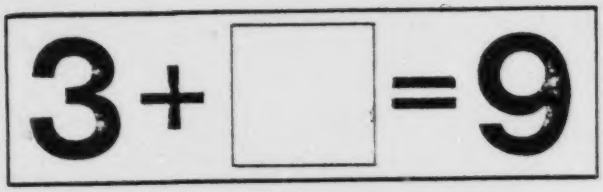
1. Hold up the card with 6 + 3. Say	POINT TO THE CARD WHICH IS THE SAME NUMBER AS THIS.	(17)
2. Hold up the card with 4 + 1. Say	POINT TO THE CARD WHICH IS THE SAME NUMBER AS THIS.	(18)
3. Hold up the card with 6 − 1. Say	POINT TO THE CARD WHICH IS THE SAME NUMBER AS THIS.	(19)

Materials: cards with 6 + 3, 4 + 1, 6 − 1

Response	Percent
17. No attempt	12.0
Correct—5 + 4	39.9
Incorrect—no matching noted	15.2
Incorrect—3 + 2 (matched 3's)	32.9

Response	Percent
18. No attempt	10.1
Correct—3 + 2	42.4
Incorrect—no matching noted	11.4
Incorrect—5 + 2 (matched 4's)	35.4
Incorrect—other	6
19. No attempt	13.3
Correct—3 + 2	38.6
Incorrect—no matching noted	28.5
Incorrect—5 + 4	19.6



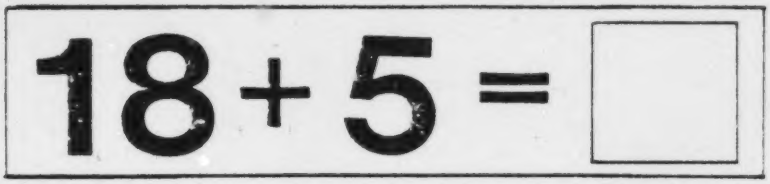
1. Point to box, say	WHAT NUMBER GOES IN THE BOX? (20)

Response	Method	Percent
No attempt		15.8
Correct	Immediate	13.2
Correct	Subtracted	.7
Correct	Counted on	12.5
Correct	Other	12.5
Incorrect	Immediate	13.2
Incorrect	Counted on	7.9
Incorrect	Other	24.3

1. Say	START AT SIX AND COUNT BACKWARDS FOR ME. (21)
2. If no response, say	I WANT YOU TO COUNT LIKE THIS. 6, 5, 4. NOW YOU DO IT. (22)
3. If the student stops before 1, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 1 or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
No attempt	2.7
Counted down to 1 or 0	89.5
Counted down to 4	4.0
Other response	3.9

Note: 13.2% required second instructions.



Place 50 beans in front of the student. Point to the problem, say

USE THE BEANS TO FIND THE ANSWER TO THE PROBLEM. (23)

If the student verbalizes the answer, but does not use the beans, say

NOW SHOW ME HOW TO USE THE BEANS TO FIND THE ANSWER.

If the student uses the beans, but does not verbalize the answer, ask

WHAT IS THE ANSWER?

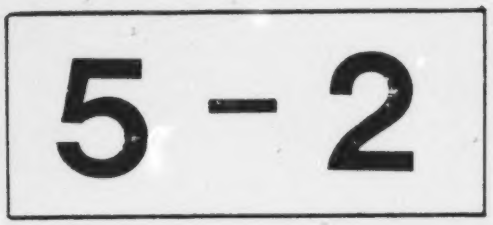
Materials: 50 beans

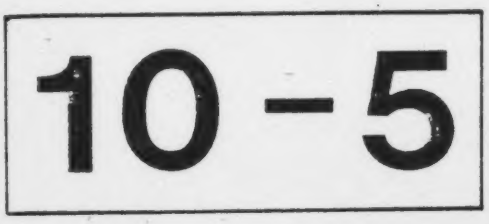
Response	Method	Percent
No attempt		3.3
Correct	Answered 23 without using beans	2.0
Correct	Used beans to construct equation 18 + 5 = 23 (made 3 sets)	38.2
Correct	Counted on	25.0
Incorrect	Immediate	2.0
Incorrect	Attempted to count 18, 5, then 23	14.5
Incorrect	Counted on	4.6
Incorrect	Other	10.5

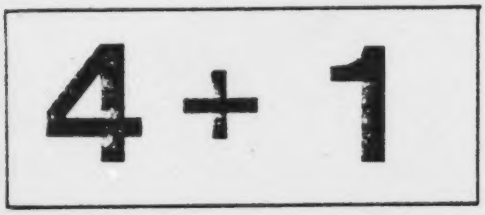
1. Point to the numerals. Ask

WHICH IS MORE? (24)

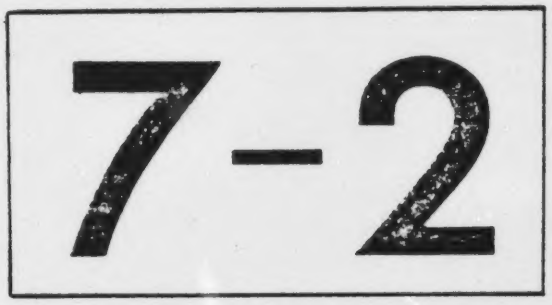
Response	Percent
No attempt	1.3
Correct	46.4
Incorrect	52.3







Cards examiner holds up



Cards facing student

1. Hold up the card with 5 - 2. Say	POINT TO THE CARD WHICH IS THE SAME NUMBER AS THIS. (25)
2. Hold up the card with 10 - 5. Say	POINT TO THE CARD WHICH IS THE SAME NUMBER AS THIS. (26)
3. Hold up the card with 4 + 1. Say	POINT TO THE CARD WHICH IS THE SAME NUMBER AS THIS. (27)

Materials: cards with 5 - 2, 10 - 5, 4 + 1

25. Response	Percent
No attempt	8.9
Correct—4 - 1	39.2
Incorrect--no matching noted	12.0
Incorrect—7 - 2 (matched 2's)	38.6
Incorrect—other	1.3

26. Response	Percent
No attempt	11.4
Correct—7 - 2	46.2
Incorrect—no matching noted	24.7
Incorrect—4 - 1	17.1
Incorrect—other	.6

27. Response	Percent
No attempt	7.0
Correct—7 - 2	26.6
Incorrect—no matching noted	9.5
Incorrect—4 - 1 (matched 4's and 1's)	53.8
Incorrect—other	3.2

23 − 7 = ☐

Place 50 beans in front of the student. Point to the problem. Say	USE THE BEANS TO FIND THE ANSWER. (28)
If the student verbalizes the answer but does not use the beans, say	NOW SHOW ME HOW TO USE THE BEANS TO FIND THE ANSWER.
If the student uses the beans but does not verbalize the answer, ask	WHAT IS THE ANSWER?

Materials: 50 beans

Response	Method	Percent
No attempt		7.9
Correct	Counted back	2.6
Correct	Counted 23, 7, then 16	34.9
Correct	Other	1.4
Incorrect	Addition	29.6
Incorrect	Counted back	2.0
Incorrect	Attempted to count 23, 7, then 16	9.9
Incorrect	Other	11.9

1. Say	START AT 44 AND COUNT BACKWARDS FOR ME. (29)
2. If no response, say	I WANT YOU TO COUNT LIKE THIS. 44, 43, 42. NOW YOU DO IT. (30)
3. If the student stops before 25, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 25 or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
No attempt	6.6
Counted down to 25	40.1
Counted down to 30	3.9
Counted down to 40	19.7
Counted down to 42	15.1
Other response	14.5

Note: 45.4% required second instructions.

7 4

1. Point to the numerals. Ask	WHICH IS LESS? (31)

Response	Percent
No attempt	4.6
Correct	82.2
Incorrect	13.2

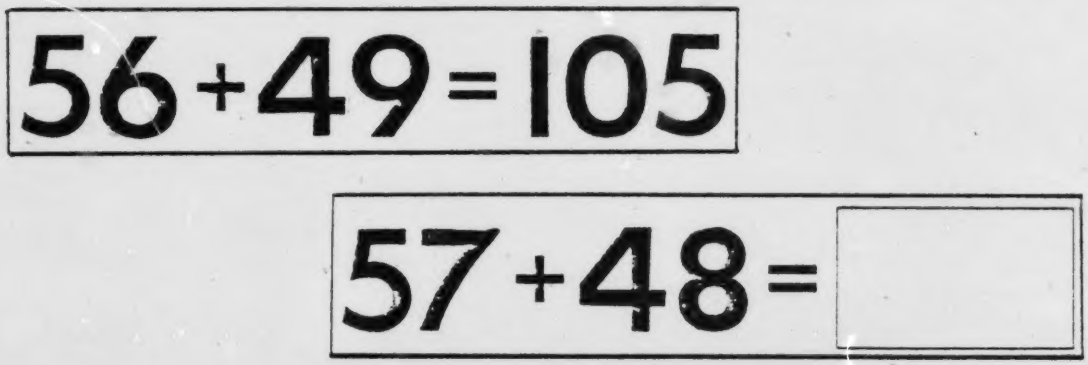
1. Say	COUNT BY TENS FOR ME. (32)
2. If no response or if the student starts at 1, say	I WANT YOU TO COUNT LIKE THIS. TEN, TWENTY, THIRTY. NOW YOU DO IT. (33)
3. If the student stops before 130, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 130, or makes 2 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
No attempt	6.6
Counted to 130	28.9
Counted to 100	42.7
Counted to 50	11.9
Counted to 30	5.3
Other response	4.6

Note: 35.5% required second instructions.

1. Point to the first equation, say If the student can not read the equation, do not continue this item.	READ THIS FOR ME.
2. Point to the second equation, say	TELL ME AS QUICKLY AS YOU CAN WHAT GOES IN THE BOX. (34)
3. Ask	HOW DID YOU GET THAT? (35)

Response to Item 34	Response to Item 35	Percent
No attempt—read first equation		28.3
No attempt—couldn't read first equation		4.6
Correct	Added	21.7
Correct	Pattern	6.6
Correct	Other	7.9
Incorrect	Added	3.9
Incorrect	Pattern	2.0
Incorrect	Other	25.0



1. Point to the first equation, say (If the student cannot read the equation, do not continue this item.)	READ THIS FOR ME.
2. Point to the second equation, say	TELL ME AS QUICKLY AS YOU CAN WHAT GOES IN THE BOX. (36)
3. Ask	HOW DID YOU GET THAT? (37)

Response to Item 36	Response to Item 37	Percent
No attempt—read first equation		42.1
No attempt—couldn't read first equation		11.2
Correct	Added	1.3
Correct	Pattern	8.6
Correct	Other	7.2
Incorrect	Added	2.6
Incorrect	Pattern	5.3
Incorrect	Other	21.8

Point to box, say

WHAT NUMBER GOES IN THE BOX? (38)

Response	Method	Percent
No attempt		25.0
Correct	Immediate	4.6
Correct	Counted on	16.4
Correct	Other	5.3
Incorrect	Immediate	15.8
Incorrect	Counted on	7.9
Incorrect	Other	25.0

1. Place 6 bundles of 10 straws each in front of the student in the order 1, 1, 1, 1, 1, 1. Say

EACH BUNDLE HAS 10 STRAWS. HOW MANY STRAWS ARE THERE? (39)

Materials: 6 bundles of 10 straws each

Response	Method	Percent
No attempt		5.9
60	Counted by tens	48.0
60	Counted by ones	2.0
60	Other method	2.6
6	Counted by ones	17.1
Other incorrect response		23.1

1. Place 3 bundles of 10 straws each in front of the student. Say	THERE ARE TEN STRAWS IN EACH BUNDLE.
2. Put 7 single straws beside the 3 bundles. Hand the student a piece of paper. Say	WRITE THE NUMBER OF STRAWS. . (40)
3. Say	HOW MANY STRAWS ARE THERE? (41)

Materials:

3 bundles of 10 straws each
7 single straws
paper
pencil

40. Response	Method	Percent
No attempt (written)		6.6
Correct	Counted by tens and ones	43.4
Correct	Counted by ones	2.6
Incorrect	1, 2, 3, ..., 10 (counted bundles as one)	6.6
Incorrect	Other	38.8

41. Response	Percent
No attempt (verbal)	9.2
Correct	45.3
Incorrect	45.4

34

1. Place 6 bundles of 10 straws each, and 9 single straws in front of the student. Point to the numeral '34' Say	SHOW ME THIS NUMBER WITH THE STRAWS. (42)

Materials:

6 bundles of 10 straws each
9 single straws

Response	Method	Percent
No attempt		16.4
Correct	Counted by tens and ones	42.8
Correct	Counted by ones	4.6
Correct	Other	.7
Incorrect	Counted by tens and ones	3.9
Incorrect	Counted by ones	8.6
Incorrect	Counted all objects, singles and bundles, as one	7.9
Incorrect	Other error	15.1

1. Place 6 bundles of 10 straws each and 9 single straws to the student's left and say

SHOW ME FORTY-FIVE STRAWS. (43)

Materials:

6 bundles of 10 straws each
9 single straws

Response	Method	Percent
No attempt		18.4
Correct	Counted by tens and ones	44.1
Correct	Counted by ones	3.9
Correct	Other	3.3
Incorrect	Counted by tens and ones	3.3
Incorrect	Counted by ones	11.2
Incorrect	Counted all objects, singles and bundles, as one	5.3
Incorrect	Other error	10.5

Point to box, say

WHAT NUMBER GOES IN THE BOX? (44)

Response	Method	Percent
No attempt		34.2
Correct	Immediate	13.2
Correct	Subtracted	0
Correct	Counted on	3.9
Correct	Other	7.2
Incorrect	Immediate	15.8
Incorrect	Subtracted	.7
Incorrect	Counted on	4.6
Incorrect	Other	20.4

1. Place a red poker chip in front of the student. Point to it and say Place another red poker chip above the first poker chip (⁘). Say Place three (3) more red poker chips in the column (⁝). As each chip is placed, say	EACH RED IS TEN. THIS IS TEN. THIS IS TEN.
2. Point to all the chips and ask	HOW MUCH ALL TOGETHER? (45)

Materials: 5 red poker chips

Response	Method	Percent
No attempt		3.3
50	Counted by tens	55.2
50	Other method	1.4
5	Counted by ones	27.6
5	Other method	2.0
Other incorrect		10.5

1. Place the paper and pencil to the student's right. Place 4 red poker chips in a column (⁝). Point to each red chip and say	THIS IS TEN, THIS IS TEN, THIS IS TEN, THIS IS TEN.
2. Place a white poker chip starting a second column to the examiner's left of the red chips (∘⁝). Say	EACH WHITE IS ONE.
3. Place 2 more white poker chips in the left column and point to each white chip (∘∘⁝). Say	THIS IS ONE, THIS IS ONE.
4. Point to all the chips and say	WRITE HOW MUCH ALL TOGETHER. (46)
5. Ask	HOW MUCH ALL TOGETHER? (47)

Materials: 4 red poker chips
3 white poker chips
paper
pencil

Response	Method	Percent
46. No attempt (written)		7.9
Correct	Counted by tens and ones	43.5
Incorrect	1, 2, 3, ..., (counted each as one)	28.9
Incorrect	Other	19.8
47. No attempt (verbal)		7.2
Correct		44.8
Incorrect		48.0

37

1. To the student's right, place a pile of 6 red chips and a pile of 9 white chips, with the red chips closest to the student. Point to the chips and say Point to the number and say	EACH RED IS TEN. EACH WHITE IS ONE. SHOW ME THIS NUMBER WITH THE CHIPS. (48)

Materials:

6 red poker chips
9 white poker chips

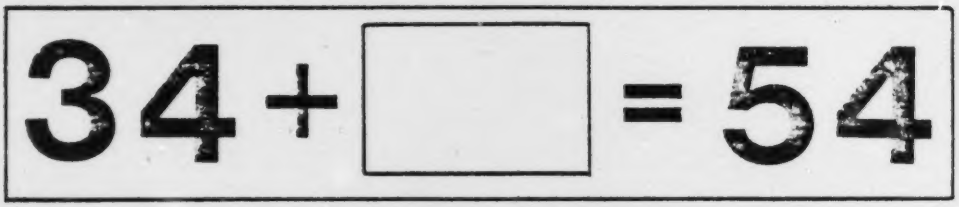
Response	Method	Percent
No attempt		15.1
Correct	Counted by tens and ones	43.4
Correct	Other	2.0
Incorrect	Counted by tens and ones	6.6
Incorrect	Counted all chips, red and white, as one	17.8
Incorrect	Other error	15.1

1. To the student's right, place a pile of 6 red chips and a pile of 9 white chips, with the red chips closest to the student. Point to the chips and say	EACH RED IS TEN. EACH WHITE IS ONE.
2. Say	SHOW ME FIFTY-TWO WITH THE CHIPS. (49)

Materials:

6 red poker chips
9 white poker chips

Response	Method	Percent
No attempt		17.1
Correct	Counted by tens and ones	46.7
Correct	Other	2.0
Incorrect	Counted by tens and ones	3.9
Incorrect	Counted all chips, red and white, as one	19.1
Incorrect	Other	11.2



1. Point to box, say	WHAT NUMBER GOES IN THE BOX? (30)

Response	Method	Percent
No attempt		42.8
Correct	Immediate	5.9
Correct	Subtracted	1.3
Correct	Counted on	2.0
Incorrect	Immediate	39.5
Incorrect	Subtracted	2.0
Incorrect	Counted on	6.6

1. Say	START AT 26 AND COUNT BY TENS FOR ME. (31)
2. If no response or if the student counts by 1's, say	I WANT YOU TO COUNT LIKE THIS. TWENTY-SIX, THIRTY-SIX, FORTY-SIX, FIFTY-SIX. (32)
3. If the student stops before 126, say	THAT'S FINE. KEEP GOING.
4. If the student counts to 126, or makes 3 consecutive errors, say	THAT'S FINE. YOU MAY STOP NOW.

Response	Percent
No attempt	23.0
Counted to 96	49.3
Counted to 56	8.5
Counted to 46	8.6
Other response	10.6

Note: 78.3% required second instructions.

APPENDIX D

OTIS-LENNON MENTAL ABILITY TEST

The Otis-Lennon Mental Ability Test was administered to each child in the sample. This test measures scholastic aptitude with the purpose of predicting academic success and yields a Deviation IQ (DIQ) and Mental-Age Equivalent for each child. The Primary II Level and the Elementary I Level were administered to Grades 1 and 2, respectively.

TABLE 3

SUMMARY OF DIQ DATA BY GRADE

Variable	Mean	S. D.	Median	Min.	Max.
Grade 1					
Age (mos.)	75.81	4.35	75.53	68	93
Otis-Lennon MA (mos.)	77.56	16.48	75.75	48	129
Otis-Lennon DIQ	101.14	19.17	101.20	54	150
Grade 2					
Age (mos.)	88.49	4.59	88.25	72	106
Otis-Lennon MA (mos.)	94.07	17.97	94.15	61	137
Otis-Lennon DIQ	104.61	18.74	106.25	62	150

APPENDIX E

KEYMATH DIAGNOSTIC ARITHMETIC TEST

The KeyMath Diagnostic Arithmetic Test is an individually administered power test covering topics from Kindergarten through Grade 9. It is designed to provide a diagnostic assessment of the student's skills in mathematics. The items are divided into 14 subtests organized into three major areas — Content, Operations, and Applications:

CONTENT	OPERATIONS	APPLICATIONS
A. Numeration	D. Addition	J. Word Problems
B. Fractions	E. Subtraction	K. Missing Elements
C. Geometry and Symbols	F. Multiplication	L. Money
	G. Division	M. Measurement
	H. Mental Computation	N. Time
	I. Numerical Reasoning	

The test data yield a total raw score, a score for each subtest, and a mathematics grade equivalent.

A summary of the data obtained from the KeyMath Diagnostic Arithmetic Test is presented in Tables 4 and 5 for Grades 1 and 2, respectively.

A mean grade equivalent for each KeyMath subscale was approximated from the mean raw scores using the KeyMath Diagnostic Profile.

APPENDIX E

TABLE 4

SUMMARY OF KEYMATH DATA, GRADE 1

Variable	Mean	S. D.	Median	Min./Max.	Grade Equivalent of Mean*
KeyMath Total	41.80	16.99	41.67	2 93	1.3
KM-A (Numeration)	8.84	3.58	9.57	0 14	1.3
KM-B (Fractions)	1.36	1.08	1.40	0 7	1.5
KM-C (Geometry and Symbols)	7.11	2.17	7.08	0 14	1.2
KM-D (Addition)	2.95	1.63	2.86	0 8	.8
KM-E (Subtraction)	2.56	1.12	2.70	0 6	.5
KM-F (Multiplication)	.50	.88	.26	0 7	.5
KM-G (Division)	1.41	.89	1.64	0 7	1.7
KM-H (Mental Computation)	1.56	.96	1.64	0 5	1.4
KM-I (Numerical Reasoning)	1.16	1.36	.87	0 7	.8
KM-J (Word Problems)	3.48	1.60	3.57	0 8	1.5
KM-K (Missing Elements)	.17	.76	.04	0 6	.5
KM-L (Money)	2.37	1.59	2.06	0 9	1.4
KM-M (Measurement)	4.72	2.87	4.68	0 16	1.5
KM-N (Time)	3.70	2.28	3.64	0 11	1.3

*Estimated from KeyMath Diagnostic Profile

APPENDIX E

TABLE 5

SUMMARY OF KEYMATH DATA, GRADE 2

Variable	Mean	S. D.	Median	Min.	Max.	Grade Equivalent of Mean*
KeyMath Total	69.18	21.50	67.25	25	134	2.3
KM-A (Numeration)	11.91	2.68	12.42	3	19	2.4
KM-B (Fractions)	1.85	.95	1.82	0	5	2.1
KM-C (Geometry and Symbols)	10.66	2.30	10.69	4	17	2.3
KM-D (Addition)	5.47	2.37	5.48	0	10	2.0
KM-E (Subtraction)	4.45	1.74	4.85	1	8	1.9
KM-F (Multiplication)	1.11	1.18	.93	0	5	2.1
KM-G (Division)	1.74	.57	1.88	0	2	2.1
KM-H (Mental Computation)	2.66	1.15	2.43	0	6	2.5
KM-I (Numerical Reasoning)	4.16	2.35	4.53	0	9	2.3
KM-J (Word Problems)	5.06	1.96	5.01	0	11	2.4
KM-K (Missing Elements)	1.27	2.08	.31	0	7	2.8
KM-L (Money)	4.30	1.92	4.10	0	10	2.3
KM-M (Measurement)	7.90	3.79	7.17	1	19	2.5
KM-N (Time)	6.64	3.44	5.88	1	16	2.1

*Estimated from KeyMath Diagnostic Profile

APPENDIX F

STUDENT PROFILE FORMS

PMDC ARITHMETIC TEST, GRADE 1

STUDENT'S NAME _____

STUDENT PROFILE SHEET

STUDENT'S ID NUMBER _____

	Item Response Number	TASK	YES	NO	COMMENTS
Elementary Counting	1 or 2	Count from 1 to 35			
	3	Construct a set, using beans, corresponding to a written numeral (6)			
	10 or 11	Count from 6 to 15			
	14	Count a picture set of horses (3)			
	15	Count a picture set of cows (7)			
	16 or 17	Count a picture set of animals (10)			
	35	Construct a set with 3 members in response to oral directions			
	36	Construct a set with 4 members in response to oral directions			
	46 or 47	Count back from 5 to 1			
Advanced Counting	23 or 24	Count from 80 to 112			
	29 or 30	Count by tens from 10 to 120			
	40 or 41	Count by twos from 2 to 20			
	44 or 45	Count by tens to determine the number of crayons in four boxes, each with 10 crayons			
Set Equivalence	9	Establish the number equivalence (5) of two picture sets without explicit directions to count the sets or to establish 1-1 matching between the sets			
	12	Construct a set with more members than a given pictured set (7)			
	20 or 22	Determine whether two sets have the same number (3) of members after the two sets were constructed by 1-1 matching			
	26	Determine the number of members in a set having established that it is equivalent to a set with 7 members			
	28	Construct a set with less members than a given pictured set (7)			
	42	Construct a set with one more member than a given pictured set (7)			
	48	Construct a set with one less member than a given pictured set (7)			
	52	Construct a set with the same number (7) of members as a given pictured set			
Ordering Numbers	4	Tell the number which comes just after a given number (3)			
	5	Tell the number which comes just after a given number (8)			
	6	Tell the number which comes just after a given number (13)			
	32	Tell the number which comes just before a given number (5)			
	33	Tell the number which comes just before a given number (8)			
	34	Tell the number which comes just before a given number (14)			
	49	Tell the number which comes between two numbers (3 and 5)			
	50	Tell the number which comes between two numbers (7 and 9)			
	51	Tell the number which comes between two numbers (14 and 16)			
	53	Tell the number which comes between two numbers (6 and 4)			
Addition Subtraction	13	Solve an addition problem-solving exercise (sum 5), oral directions			
	27	Solve a subtraction problem-solving exercise (minuend 7), oral directions			
	31	Find the number of a picture set (C) where one subset is explicitly shown (A) and a second subset is covered (B); N (B) is given			
	37	Given two disjoint sets (with 3 and 4 elements), determine how many altogether without joining the sets			
	39	Determine the number (7) of a set which was formed by joining two disjoint sets with 3 and 4 members			
	43	Solve a missing addend problem-solving exercise (sum 5), oral directions			
Class Inclusion	8	Answer a class inclusion question, without explicit directions to count the sets (numbers 10 or less)			
	18	Answer a class inclusion question, after having counted the members in each set (numbers 10 or less)			

PMDC ARITHMETIC TEST, GRADE **2**

STUDENT PROFILE SHEET

STUDENT'S NAME _____

STUDENT'S ID NUMBER _____

Strand	Item Response Number	TASK	YES	NO	COMMENTS
Elementary Counting	1	Count a picture set of dots (13)			
	6 or 7	Count from 6 to 15			
	9	Count a picture set of horses (3)			
	10	Count a picture set of cows (7)			
	11 or 12	Count a picture set of animals (10)			
	14 or 15	Count from 35 to 46			
	21 or 22	Count back from 6 to 1			
Advanced Counting	29 or 30	Count back from 44 to 25			
	32 or 33	Count by tens from 10 to 130			
	39	Determine the number of a set represented by 6 bundles of ten straws			
	45	Determine the number of a set represented by 5 red chips, each red chip stands for ten			
	51 or 52	Count by tens from 26 to 126			
Place Value	40	Write the numeral for a set represented by 3 bundles of ten straws and 7 single straws			
	41	Tell the number of a set represented by 3 bundles of ten straws and 7 single straws			
	42	Construct a set using bundles of ten straws and single straws corresponding to a written numeral (34)			
	43	Construct a set using bundles of ten straws and single straws, with a given number of members (45), in response to oral directions			
	46	Write the numeral for a set represented by 5 red chips (each stands for 10) and 3 white chips (each stands for 1)			
	47	Tell the number of a set represented by 5 red chips (each stands for 10) and 3 white chips (each stands for 1)			
	48	Construct a set using red chips (10 each) and white chips (1 each) corresponding to a written numeral (37)			
	49	Construct a set using red chips (10 each) and white chips (1 each) to represent a given number (52), in response to oral directions			
Addition Subtraction	5	Use counters (beans) to solve an addition problem, sum 6			
	8	Use counters (beans) to solve a subtraction problem, minuend 7			
	23	Use counters (beans) to solve a addition problem, 2-digit (18) plus 1-digit (5)			
	28	Use counters (beans) to solve a subtraction problem, 2-digit (23) minus 1-digit (7)			
Missing Addend	20	Solve a written missing addend problem, sum 9			
	38	Solve a written missing addend problem, sum 27			
	44	Solve a written missing addend problem, involving multiples of 10 only			
	50	Solve a written missing addend problem, answer a multiple of ten (30)			
Patterns	34 & 35	Solve (without computation) an addition problem by using a related equation, 2-digit sum (24)			
	36 & 37	Solve (without computation) an addition problem by using a related equation, 3-digit sum (105)			
Ordering Numbers	2	Order four numbers (2, 3, 5 and 9) from smallest to largest			
	16	Tell which of two numbers (8 and 12) is more			
	24	Tell which of two numbers (19 and 31) is more			
	31	Tell which of two numbers (7 and 4) is less			
Equivalent Names	17	Identify names for the same number (6+3 and 5+4)			
	18	Identify names for the same number (4+1 and 3+2)			
	19	Identify names for the same number (6-1 and 3+2)			
	25	Identify names for the same number (5-2 and 4-1)			
	26	Identify names for the same number (10-5 and 7-2)			
	27	Identify names for the same number (4+1 and 7-2)			
Class Inclusion	4	Answer a class inclusion question, without explicit directions to count the members of sets (numbers 10 or less)			
	13	Answer a class inclusion question, after having counted the members in each set (numbers 10 or less)			